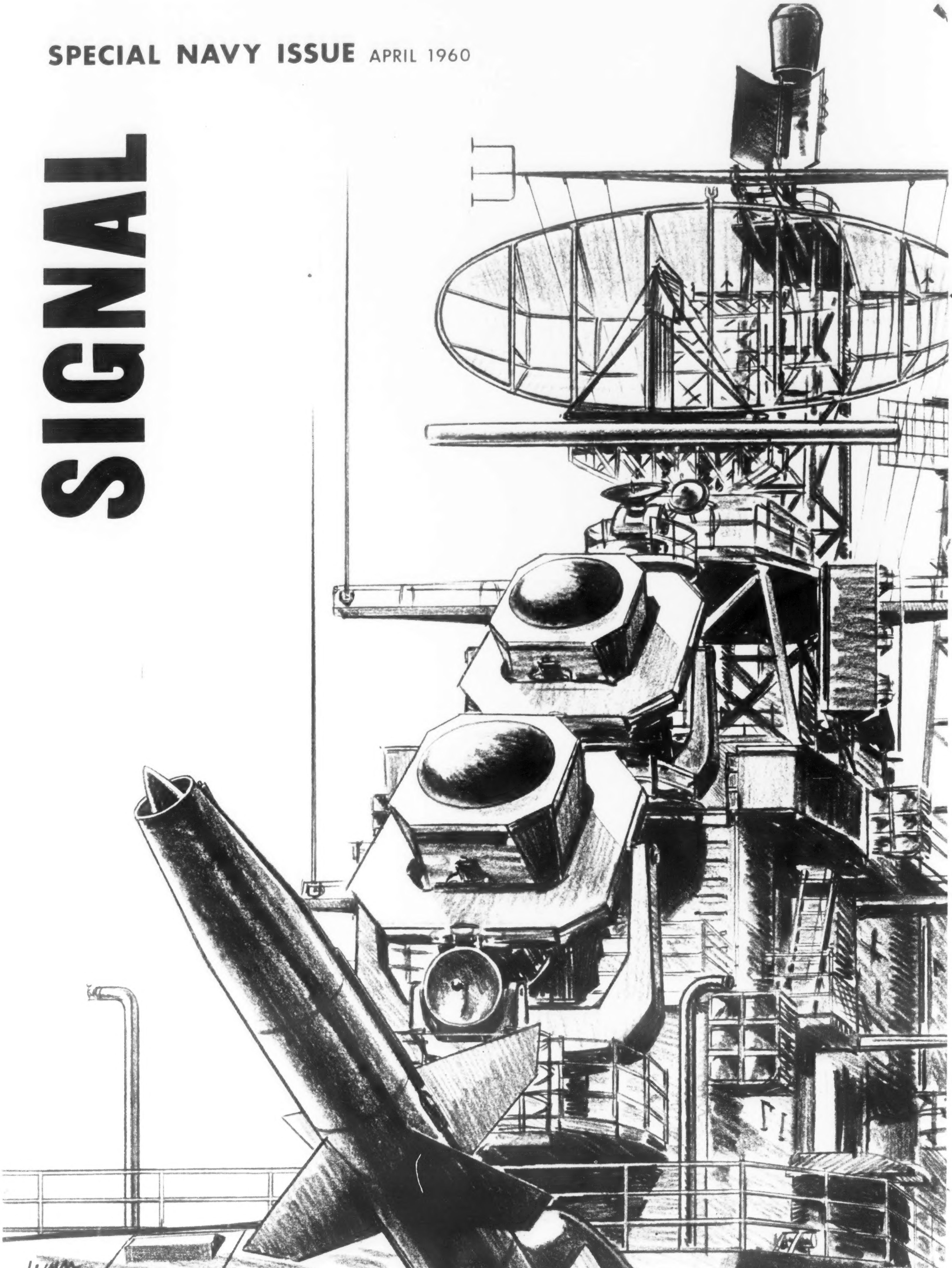
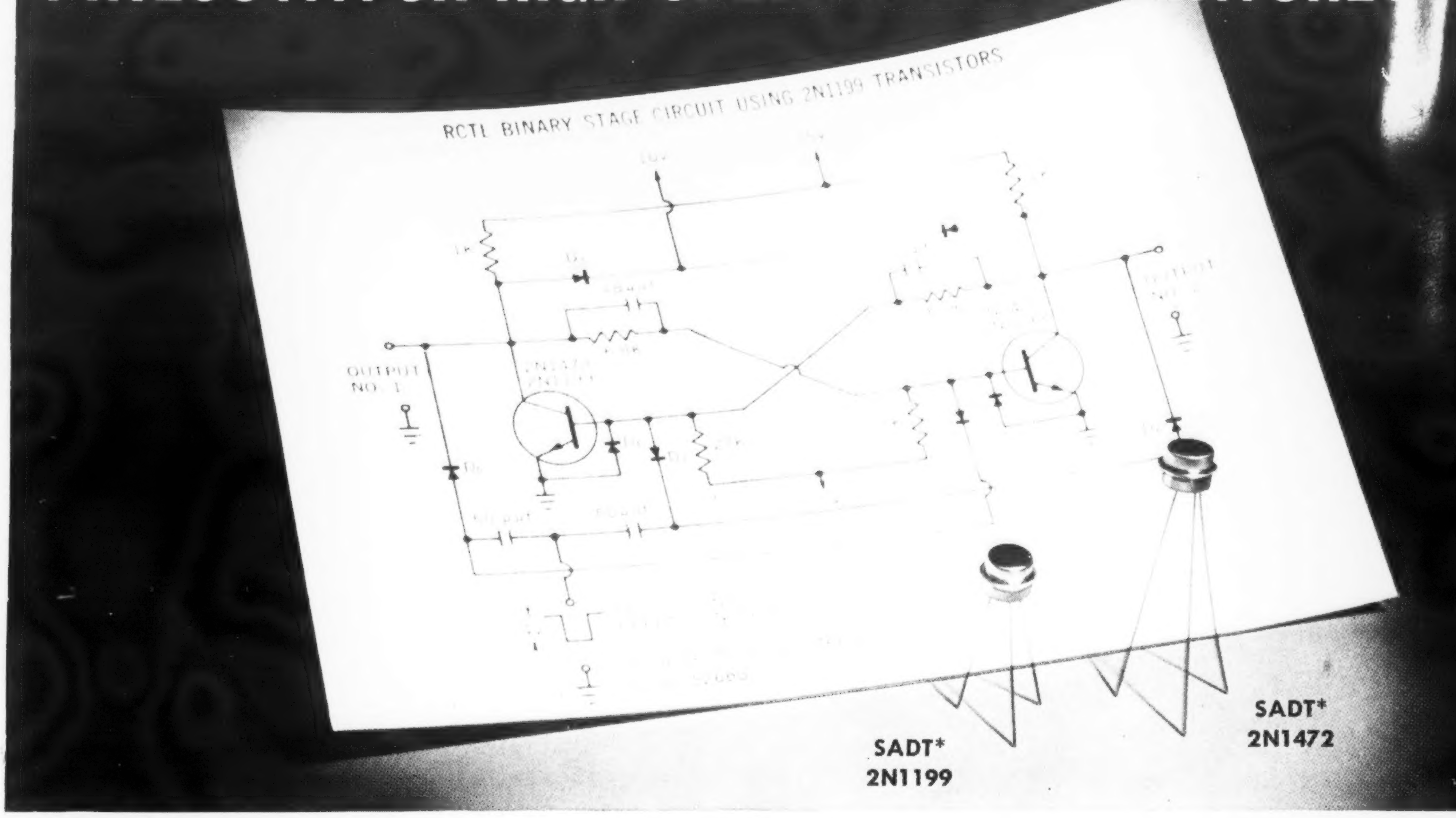
SPECIAL NAVY ISSUE APRIL 1960

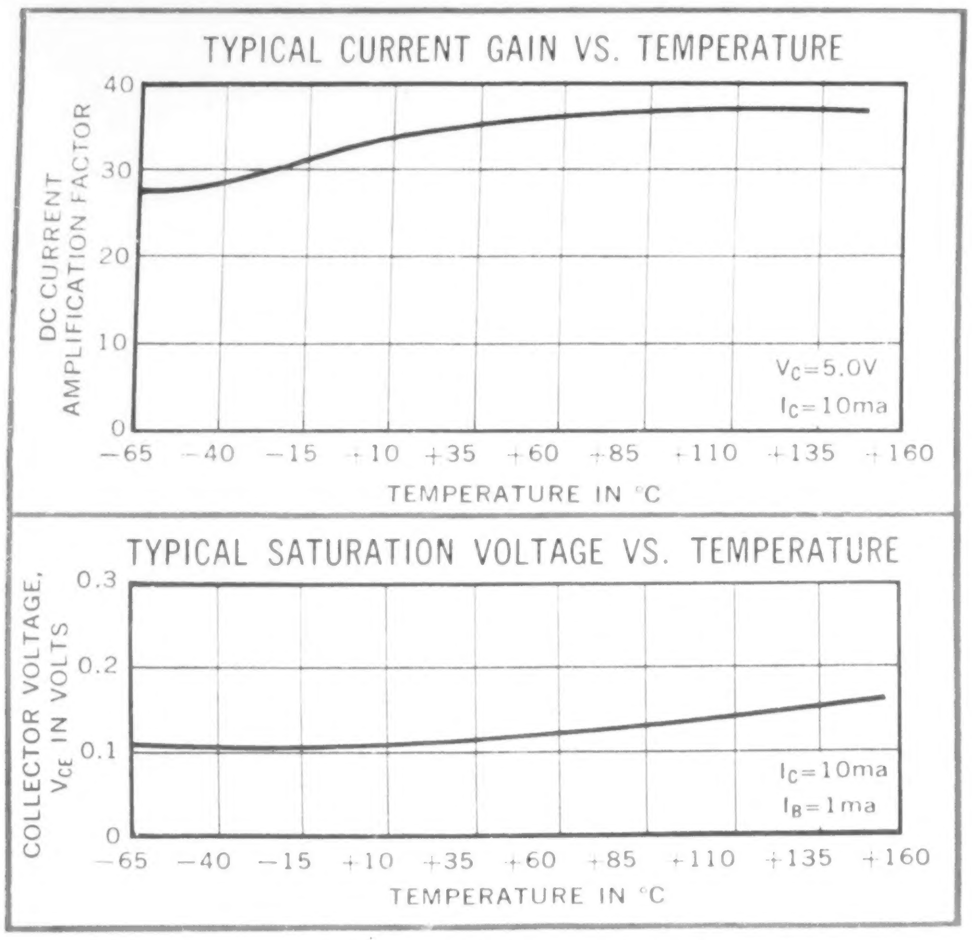
SIGNAL



PHILCO...FOR HIGH SPEED SILICON SWITCHES



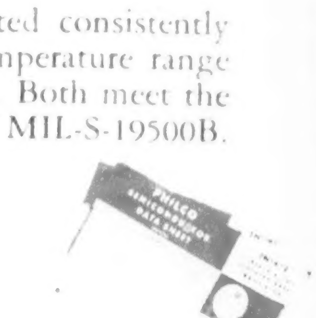
PHILCO HIGH FREQUENCY NPN SILICON TRANSISTORS OFFER EXCEPTIONALLY LOW SATURATION VOLTAGE



The high frequency response, together with the very low saturation voltage of these silicon Surface Alloy Diffused-base Transistors (typically 0.125 V), permits practical design of 5 mc pulse circuits, using conventional saturated switching configurations. With non-saturating techniques, pulse rates as high as 30 mc are obtainable. The typical switching circuit shown above will operate satisfactorily at trigger pulse rates up to 15 mc. When triggered with a 4-volt pulse at a 10 mc rate, the rise time will be typically less than 24 mμsec over a temperature range of −60°C to +130°C. The typical fall time will be less than 36 mμsec over the same temperature range.

Both of these transistors have demonstrated consistently more stable characteristics over a wide temperature range than any other silicon transistors available. Both meet the environmental and life test requirements of MIL-S-19500B.

NEW, MORE COMPLETE DATA SHEETS



The new data sheets on these transistors, for the first time, provide the designer with complete information upon which he may predict switching speeds in any circuit. They also contain the full military environmental and life test specifications, in accordance with MIL-S-19500B. Copies are available on request. Write Dept. S-160.

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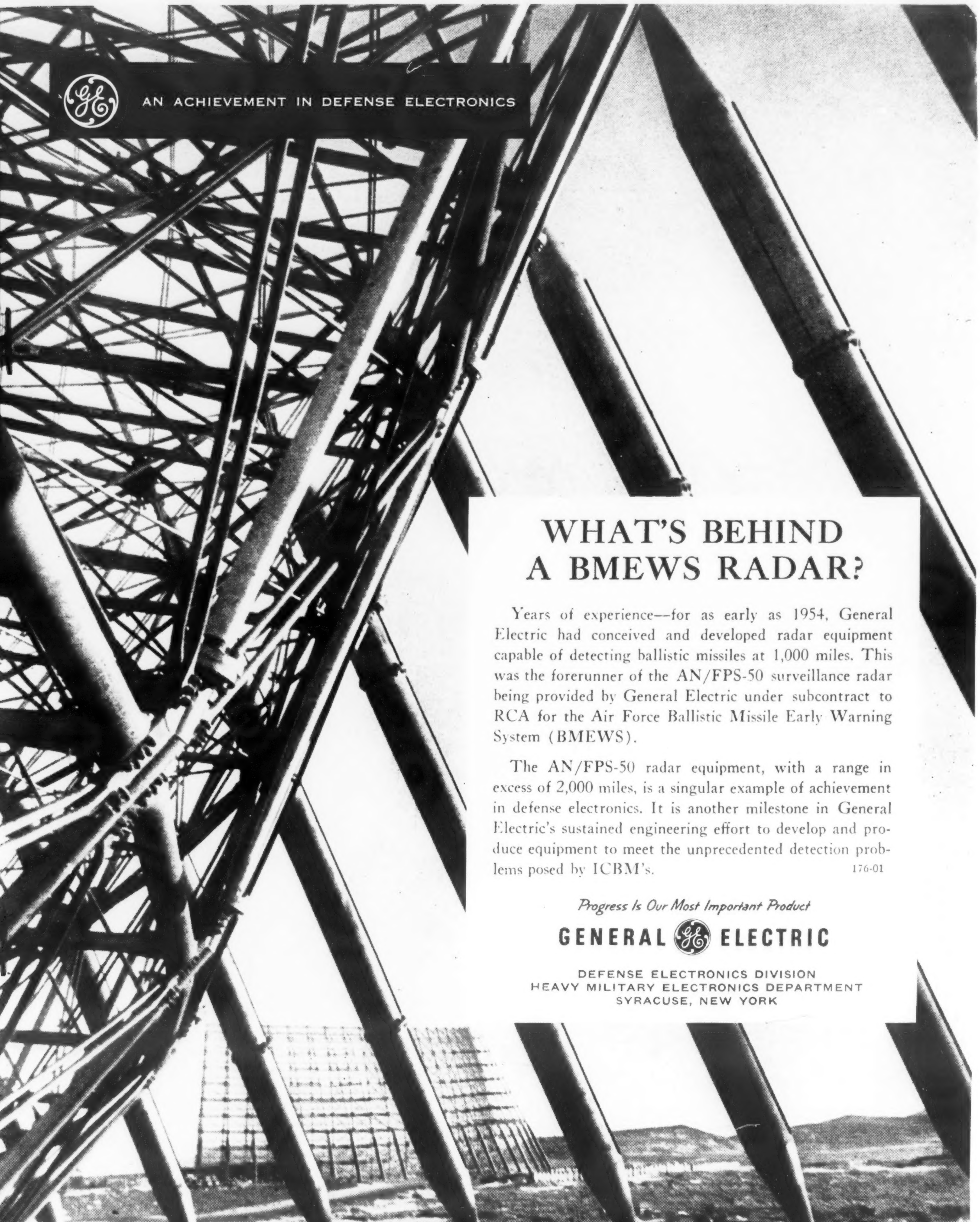
AN ACHIEVEMENT IN DEFENSE ELECTRONICS
WHAT'S BEHIND A BMEWS RADAR?
Years of experience—for as early as 1954, General Electric had conceived and developed radar equipment capable of detecting ballistic missiles at 1,000 miles. This was the forerunner of the AN/FPS-50 surveillance radar being provided by General Electric under subcontract to RCA for the Air Force Ballistic Missile Early Warning System (BMEWS).
The AN/FPS-50 radar equipment, with a range in excess of 2,000 miles, is a singular example of achievement in defense electronics. It is another milestone in General Electric's sustained engineering effort to develop and produce equipment to meet the unprecedented detection problems posed by ICBM's.
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SYRACUSE, NEW YORK

Crosley Amplifiers—
Under The Polar Ice Cap

Today's Navy calls for reliability. New submarines and surface ships demand technical mastery in every phase of development. When amplifiers used in underwater torpedo fire-control systems failed after a few hours of operation, the Navy turned to Avco's Crosley Division for help.

Crosley engineering solved the problem: The product: an amplifier that operates without failure for 2000 hours or longer.

Recently the Navy decided to install Crosley amplifiers in fire-control systems aboard many of its modern vessels—including the nuclear-powered submarines *S.S.(N)Nautilus, S.S.(N)Skate, S.S.(N)Sargo,* and *S.S.(N) Swordfish.* When the *Skate* made its historic journey under the Arctic ice cap in 1958, it had Crosley-made amplifiers aboard. Today, some ten different types of Crosley amplifiers are used by ships of the U.S. Navy.

Crosley's talent for design, engineering, and manufacture of transistorized amplifiers has secured an important place for this critical equipment. It is reflected in airborne television gun-sighting equipment purchased by the U.S. Air Force, in the huge FPS-26 height finder radar for perimeter defense, and in the Navy's *Polaris* missile system.

For more information on amplifiers designed and produced by Crosley, write . . . Vice President, Marketing-Defense Products, Crosley Division, Avco Corporation, Cincinnati 25, Ohio.

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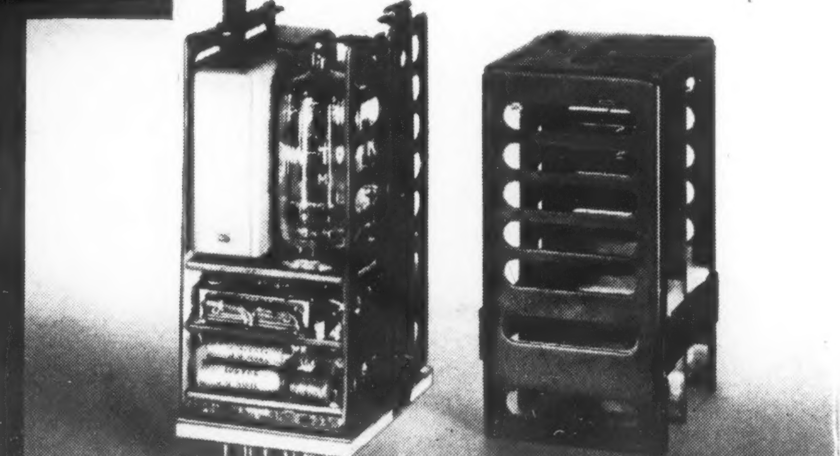
Avco/Crosley

One of a series of midget servo amplifiers developed by Avco/Crosley for use in underwater fire-control systems.



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COVER

SIGNAL's cover, based on a scale model of the guided missile cruiser, USS Galveston (CLG-3), depicts the artist's impression of the vast array of shipboard communications and electronics equipment needed at sea in the Missile Age.

Authors are entirely responsible for opinions expressed in articles appearing in AFCEA publications, and these opinions are not to be construed as official or reflecting the views of the Armed Forces Communications and Electronics Association.

SIGNAL is published monthly by the Armed Forces Communications and Electronics Association at 1624 Eye St., N. W., Washington 6, D. C. Second class postage paid at Washington, D. C., and at additional mailing offices.
Subscription rate to members of the AFCEA: 1 year (12 issues), $5.00. To non-members, $7.00. To foreign post offices, $8.00. Single copies, $1.00 each. Printed in U.S.A. by Monumental Printing Co. at Baltimore, Md. The publisher assumes no responsibility for return of unsolicited manuscripts or art. When sending change of address, please list the old and the new address, and allow 3 weeks for delivery of first copy.

BPA

SIGNAL

Communications-Electronics-Photography
Journal of the Armed Forces Communications and Electronics Association

VOLUME XIV | APRIL 1960 | NUMBER 8

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SIGNAL'S
U. S. NAVY ISSUE

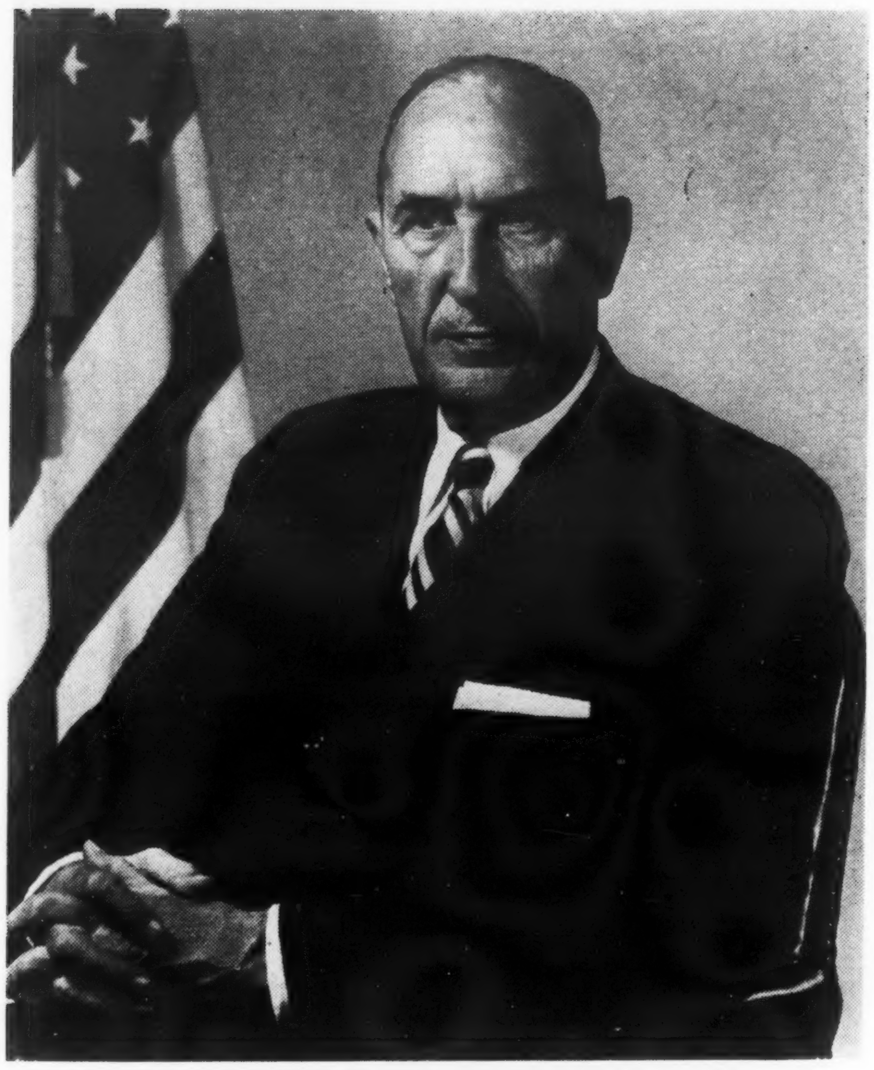
LETTER OF APPRECIATION

As National President, it is a profound privilege to express on behalf of the entire membership of the Armed Forces Communications and Electronics Association our deep appreciation to the authors who have made such an outstanding contribution in support of SIGNAL's special Navy issue. I understand from our Editor, W. J. Baird, that space limitations have precluded the publication of some of the articles, however, some of these have been scheduled for a subsequent issue. It is gratifying to note that the response to SIGNAL's request for subject material on Naval communications was 100 percent. Such cooperation is valued most highly and we commend each author for a job well done.

This is the second special issue in our "Service Series," the first being the U. S. Army Signal Corps Components issue of March 1959. Next year SIGNAL will feature communications and electronics in the U. S. Air Force.

These special service issues are but another symbolic recognition of the Association's industry-military cooperation in support of our educational objectives. It is our firm conviction that they provide a climate in the field of communications and electronics whereby a more comprehensive understanding results, progress becomes a reality, and national security is strengthened.

B. H. OLIVER, JR.
National President, AFCEA
Vice President Upstate
New York Telephone Company



William B. Franke
Secretary of the Navy

Every ship and aircraft in the U. S. Navy carries communication-electronic equipment without which modern high speed operations on a world-wide basis would be impossible. The combat readiness of the Navy and Marine Corps is directly related to the efficient operation of such equipment. A necessary, but sometimes little understood preliminary to operations is procurement, a matter of major concern to the Chief of Naval Operations, Commandant of the Marine Corps, and several responsible bureaus and offices. Procurement requirements, however, cannot be pulled out of a hat. Their determination is an involved process.

Communication-electronic requirements are determined by the Office of the Chief of Naval Operations and the Commandant of the Marine Corps in close coordination with the appropriate technical bureaus and the operating forces. These requirements become a part of many major programs of the Navy. Once determined, they are set forth in the Navy Program Objectives for approval by the Secretary of the Navy and promulgation, about 18 months before the beginning of the budget year in which they will be considered. The Navy Program Objectives are not limited to Navy programs, but contain items of Marine Corps interest. However, when certain budget matters are of great importance to the Marine Corps, it is considered as a separate service reporting directly to the Under Secretary (Comptroller) and the Secretary of the Navy.

Once programs are documented in the Programs Objectives, the Commandant of the Marine Corps and the appropriate Navy bureaus and offices formulate individual supporting budgets. These budgets then go to the Office of the Comptroller of the Navy where they are worked into an over-all budget for the Department of the Navy. Here is emphasized the bilineal organization of the Navy Department; the Program Objectives are the result of military planning in the Office of the Chief of Naval Operations, but with the transformation of plans to budgets they become a matter for cognizance of the civilian side of the organization, the Comptroller, who is also Under Secretary of the Navy.

The Office of the Comptroller, in addition to holding formal budget reviews with the Commandant of the Marine Corps and Navy bureaus and offices, examines and analyzes the estimates. Programs are checked for balance with each other; the validity and methods of pricing are reviewed; proposed procurements are checked against known production rates; component phasing with end product delivery is studied and the whole budget is brought into conformance with policy guidance from higher authority. Matters involving major program changes are referred back to the Navy or Marine Corps as appropriate. The final result, a budget for the Department of the Navy, then goes to the Secretary of the Navy for approval and transmittal to the Secretary of Defense.

This completes the Navy's initial role in preparing the budget. Many revisions of the original work may be necessary, as it is subject to further review by the Secretary of Defense, Bureau of Budget, Joint Chiefs of Staff and the National Security Council before it is presented to the President. As finally seen by the President, it represents the best balance of programs the Navy can establish in conformance with policy and fiscal guidance from higher authority. After approval by the President, the budget is sent to Congress in the President's Budget Message. Only after Congressional approval, in the form of appropriations, can funds be expended for the procurement of material.

It would be a colossal task to determine the exact cost of each major communication-electronics item included in the budget. Due to the intricacy of modern weapons systems, communication-electronics equipment becomes a hidden part of almost every such item. An indication of their importance is gained by analysis of past budgets which shows that such equipment receives a steadily increasing proportion of the total procurement authorized. At present, communication-electronics items total approximately one-seventh of the total procurement undertaken by the Department of the Navy.

ADMIRAL ARLEIGH A. BURKE, USN
CHIEF OF NAVAL OPERATIONS

★ ★ ★ ★

The Navy is honored and pleased to have this April issue of SIGNAL Magazine devoted to Naval Communications. It is my hope that the many readers of SIGNAL will acquire a better insight and knowledge of the vital importance the Navy attaches to its voice of command, Naval Communications. It is an essential, vital and organic component of every Naval operation or endeavor.

Recent technological advances have increased the potentialities of the oceans as mobile bases for peaceful and scientific endeavor as well as for the endeavors of warfare. Thus a strong, versatile, mobile American Seapower is absolutely vital to the defense and welfare of the United States and our partners in the Free World.

The role of the Navy has required, in the past, now and in the future, that Naval Forces, of various compositions and types, be deployed to any sea area of the world.

The ability to maintain and support Naval Forces on the high seas world-wide, to command, control and coordinate them in a multitude of strategic and tactical situations, and to concentrate them quickly if required, demands the utmost in effectiveness of Naval Communications.

The effectiveness of American Seapower depends directly on the effectiveness of the exercise of command, control and coordination of our Naval Forces by Naval Commanders, and the means through which this exercise is accomplished—Naval Communications.

The greater speed, range and lethal capability of future ships, aircraft and weapons require that responsible Naval Commanders have even more complete and up-to-date knowledge of the operational situation and its environment at all times. Sound and correct decisions will have to be made instantly, and forces must react immediately and correctly in support of these decisions. These factors demand Naval Communications which are far faster, more nearly completely reliabile and more secure than ever before.

The advent of modern techniques and weapons of warfare have all but eliminated the close tactical formulation of the several years past. High speed task force, amphibious and submarine operations are now usually conducted in widely dispersed formations. However, defeat of the high speed modern submarine requires the closest coordination of air, surface and subsurface forces which, while normally operating over wide ocean areas, must be concentrated rapidly when the tactical situation demands. Thus, modern and future Naval Operations, especially as concerns the communications problems associated with silent, deep running submarines, impose demands of Naval Communications which severely tax, but will not overcome, the existing and foreseeable future state of the art.

The Armed Forces Communications and Electronics Association is a fortunate combination of military and industrial talents which will, I am sure, assist materially in the furtherance of the state of the science of communications, to the enhancement and safekeeping of our country.

GENERAL DAVID M. SHOUP
COMMANDANT OF THE MARINE CORPS

I cannot overemphasize that our units, whose function it is to destroy the enemy, will fail miserably if we neglect their communications-electronics needs.

If you are going to command, you must control. This is done by communications.

We are in a world of changes. Readiness to execute missions of today and the future depends on our keeping up with technology and, in part, adopting suitable improvements for our amphibious command and control system.

I have directed priority action toward this end.

★ ★ ★ ★

ADMIRAL JAMES S. RUSSELL, USN
VICE CHIEF OF NAVAL OPERATIONS

Adequacy in Naval Communications today means communications that are essentially perfect—capable of nearly instantaneous delivery of messages to single ships or forces distributed throughout the navigable waters of the world. Further, it means ability to communicate with selectivity, denying intelligence to all who lack the need to know, and never unintentionally compromising the locations or movements of the operating units. We must strive continuously to reach this ideal but necessary goal.

Until the turn of the century, the evolution of naval communications progressed in an almost leisurely way. A communications officer of the John Paul Jones era could easily have mastered the essentials of communication plans used by Farragut and Porter several generations later. But since the day in 1900 when the U. S. Navy first studied and evaluated the work of Guglielmo Marconi, the life of the naval communicator has become increasingly complicated.

The naval commander has many complex communications tools designed to meet his needs; but new occasions, new speeds and new weapons set up new requirements at a rapid rate. New equipment being adopted to keep the Fleet's material readiness up to date repeatedly multiply the requirements placed upon naval communications. Sensors, digital computors and analyzers are springing into intensive use in the Navy as elsewhere. These tools of decision-making must be widely adopted in the Fleet to enable the operational commanders to react with significant promptness to current naval situations. These tools, in turn, demand reliable communications if they are to be effective.

This tempo warns us that second best communications can conceivably result in great damage to National objectives. Consequently, communications and electronics both have properly emerged as principal military-economic strength members in the edifice of National power.

That nation which finds itself second best in communications-electronics will be well on the way to being second best in sea power; the U. S. Navy intends to retain the Number One position in both.

Adm. Jerauld Wright, USN
Former Commander-in-Chief, Atlantic Fleet

The U. S. Atlantic Fleet must be prepared to operate in an ocean area encompassing half the globe. Within this vast area control of the major Fleet units must be maintained whether on the surface, below the surface, or in the air. Operation of the Fleet is therefore a large and complex job and we are vitally interested in every tool that can help us do it better.

The tool which binds such a large organization together is communications. Without the ability to communicate with others each man is limited to the work that he can do with his own two hands. Without communications each unit of the Fleet is stripped of any support by other units. Communications is the means of "passing the word" and through effective communications the actions of each unit of the Fleet are coordinated with all others to form the most effective navy in the world today.

The effectiveness of the Navy today has been brought about by each commander taking a personal interest in the control and improvement of Fleet communications systems. Personal experiences throughout nearly 43 years of active duty have lead but to one conclusion, that communications is indispensable to the success of any military venture.

I am pleased to have this opportunity to greet all readers of SIGNAL magazine. Many of you are actively engaged in the difficult and vital task of providing around the clock communication service to our Armed Forces throughout the world. You have done a remarkable job in the past, and I know you will continue to do so in the future.

★ ★ ★

It gives me great pleasure to state for the readers of SIGNAL magazine my views on the importance of Naval Communications. As Commander of the Seventh Fleet, the need for positive command control of my forces was repeatedly brought home to me. In the face of possible enemy action, the commander of a force at sea cannot be actually in command unless he has positive and reliable communications with his forces and other commands.

For many years, I was one of those pressing for improvements in Naval Communications, and vowed that when I reached a position of authority, I would take positive steps to advance this most important part of the Navy. Now in a position to fulfill this vow, I find myself confronted by the very problems which have made our progress slow in the past. Through the years, I have learned that the remedies are often harder to come by than the will or intent to improve and now, in trying to promote better Naval Communications, I find that many of our troubles stem from conditions inherent in the level of the science of communications. But, there is nothing impossible in this problem, it just takes a little longer and more intense effort.

Readers of SIGNAL who are a part of industry are in a position to advance the techniques of communication to the point where their application to Naval use will match the technology of the most advanced weapons systems. We, as operators of the greatest Navy in the world, accept our responsibility to tell you what we need from the greatest electronic industry in the world to assure rapid and reliable command control of our combatant naval forces. I have every faith that together we can fulfill these aims.

Vice Adm. W. M. Beakley
Deputy Chief of Naval Operations (Fleet Operations and Readiness)

★ ★ ★

THE JOINT CHIEFS OF STAFF
WASHINGTON 25, D. C.

Joint Staff — 29 February 1960

1. The requirement that our U. S. Naval forces be ready for immediate action at any point in the far flung reaches of the world's ocean areas creates some unique problems for the naval communicator. The fact that this requirement embraces operations on, under, and over the sea further increases the proportions of this challenge.

2. The manner in which the naval communicator has responded to this challenge, and molded an effective communication system to meet these unique requirements, is a splendid tribute to the leadership and initiative of the dedicated personnel who work around the clock to insure that all hands "get the word."

JAMES DREYFUS
Major General, USA
Director for Communications-Electronics

Rear Admiral Frank Virden, USN
Assistant Chief of Naval Operations (Communications)/Director, Naval Communications

SIGNAL's readers form one of the most responsive audiences in the world on the subject of military communications-electronics. However, the majority of the readers are ashore. Therefore, it is conceivable that this issue of SIGNAL about Naval Communications which provides the voice of Naval command at sea, comes to some of you as an innovation as different, perhaps, as a strong salt breeze would be in Colorado.

This issue takes you far out to sea, for Naval Communications and Naval Operations are inseparable. In this issue illustrious Naval commanders revive for those of you who are former sailors familiar operations in the modern pattern.

Herein, the presentation of the Atlantic is handled somewhat differently from that of the Pacific Fleet. For the Pacific, the Commander-in-Chief, U. S. Pacific Fleet gives you the entire coverage of Naval Communications throughout that vast waterland which is the domain of his operating forces.

In the Atlantic, you have contributions from several Fleet and Force Commanders and a characteristically short and pungent summary from the U. S. Atlantic Fleet Commander-in-Chief, Admiral Jerauld Wright.

Worthy of an historical footnote is the fact that shortly after writing his comments on communications as a contribution to this particular issue of SIGNAL, Admiral Wright retired from active duty after 43 years' commissioned service, concluded by 6 years during which he carried with great distinction the uniquely manifold responsibilities of Supreme Allied Commander Atlantic, Commander-in-Chief Western Atlantic and Commander-in-Chief, Atlantic, in addition to that of Commander-in-Chief, U. S. Atlantic Fleet.

The Marine Corps and the Coast Guard, like the Fleets, are consumers of communications and electronics. All of the consumers are supported by the various Bureaus, their subordinate activities, and the Deputy Chiefs of Naval Operations. Included in this issue are articles giving a glimpse of some of the things that certain of these organizations are doing and what the personnel who command and serve in them are thinking about.

Among the areas not included in this issue, but reserved for a future edition, is the Bureau of Yards and Docks part in Naval Communications. The Bureau of Yards and Docks is our builder for enormous projects such as VLF Maine, and Naval Radio Research Station, Sugar Grove, and for numerous smaller projects throughout the system. Likewise omitted as a separate subject is the personnel side of the picture. Our valuable personnel in Naval Communications, from the learned researchers on through the spectrum to the salty operators are our most important assets. We are intensely proud of this hard working and highly dedicated outfit. As this issue goes to press the impact of communications and electronics on personnel programs of the Navy is being restudied at top priority in the Bureau of Naval Personnel.

As is seen from the broad coverage presented herein, Naval Communications are distributed throughout the whole of the Navy and the Marine Corps and are closely allied, for Navy purposes, with the Coast Guard. This pattern provides the best integration of communications with weapons systems, operations, administration and logistics. Such a distribution of facilities and initiative of the Navy's communications effort requires a means of coordination and direction by the Chief of Naval Operations and a common doctrine for all to pursue. The Office of the Assistant Chief of Naval Operations (Communications) was created and combined with that of the Director, Naval Communications on 5 May 1959 to facilitate these functions.

This centralization is also essential in focusing the Navy's efforts in the support of and participation in the Joint Communications Network. The Navy and the other Services must insure that the Joint Network is responsive to the requirements of the chain of command of the Nation's military forces established by the Defense Reorganization Act of 1958.

AFCEAN'S have heard views from the Director, Naval Communications several times in the past. Now many other naval persons across the entire spread of researchers, producers and users give their first hand recountals of Naval Communications as it affects their professional way of life. It is a privilege to introduce this galaxy.

[illegible] ... Navy ... The field of radio ... ever since ... [illegible] at ... Sabre ... [illegible] ... hardly surprising, therefore, that the then Navy adopted wireless communication almost as soon as it was born and has been pioneering in that field ever since. The steady march toward higher frequency in the 1920's, the development of radar in the 1930's, the myriad "crash programs" during World War II, and the pioneering in radio astronomy and moon-relay in the years since, are but a few examples of this continuing leadership.

The Navy's success in staying in the forefront of electronics development has been the result of a multiple approach to the art. The Department operates its own laboratories, where civilian scientists are intensively at work on every conceivable kind of electronics project; it supports, through a broad network of contracts, the work of hundreds of private investigators; it encourages industrial development by purchasing new products; and, it keeps a watchful eye on new discoveries or ideas, whatever the source and whether at home or abroad. In short, the Navy tries to see that no promising research bet remains uncovered.

As we in the Navy's research community look ahead, there are two ranges to our view: first, the short range, where the problems are well defined, or where we know what the problems are, but the solutions are still unknown; and second, the long range, where we are just searching for understanding ... [illegible] ... and then the ... [illegible] ... constitute ... applied research ... basic research. The two ... related and may be carried on concurrently.

Let us take CMR—communications by moon relay—as an example. Fourteen years ago a radar echo was received from the moon. But it was thought that because the echo was apparently reflected from the entire curved surface of the near hemisphere, the return pulse would be so distorted it would be useless for intelligible communication. To find out for sure, the Navy set up a basic research project at NRL. A parabolic antenna was laid in a bowl-like depression scooped out of the ground in southern Maryland, and—as is told elsewhere in this magazine—it was proved that a discrete echo can be sent via the moon. Thereupon applied research engineers set to work to develop a system that would be more efficient than a scooped-out hole in the ground. Work is continuing with the objective of developing CMR systems which will be practical for naval ship/shore and long range inter-ship communications. Meanwhile, both basic and applied research are making progress on the companion problem—using active and passive artificial satellites much in addition to moon relay.

Applied Research on Current Problems

In the field of communications, the most commanding problem facing the Navy is the need for more channels to ... [illegible] ... The ... [illegible] ... for ... [illegible] ... bands allocated to the Navy. Unless something is done immediately to relieve the situation the use of the radio waves will have to be further restricted. The most obvious solution is more accurate frequency control with transmitter and receiver precisely tuned to the same frequency with electrically small drift. Other promising lines of development are ... [illegible] ... tuned to the ... [illegible] ... use of single sideband, and ... [illegible] ... satellite relays; these, plus several ... [illegible] ... experimental systems, are described elsewhere in this issue.

Meanwhile, the problem of Fleet communications has been vastly complicated by the modification of naval tactics to meet the threat of nuclear warfare. The task forces of World War II were concentrated for mutual support against air attack; messages between ships could be sent visually or by short-range radio; there was enough time for attack warnings to be transmitted by ... [illegible]. Now, however, the task force is dispersed over hundreds of square miles of ocean, with flank elements not only out of sight but far beyond direct UHF range; air-alert systems must contemplate a missile approaching at three or four thousand miles an hour. The new tactics define both the problems to be solved and the direction of current development. A new inter-ship communication system is being

THE LOOK AHEAD

by CAPTAIN [illegible] KNAPP, USN
DIRECTOR, U. S. NAVAL RESEARCH LABORATORY

constructed that will provide message privacy; early warning systems are being greatly extended in range, and alerts are now being flashed with extreme rapidity through the use of automatic transmission, relay, and reception. In addition, an instantaneous and completely reliable recognition system is being developed for installation in friendly aircraft.

If nuclear weapons have introduced new problems, so has the launching of space vehicles. We suddenly find ourselves with earth-bound communications when we need to send and receive in the limitless dimensions of the universe. We can communicate with a satellite, but a vehicle that escapes from the earth's gravity is quickly lost into silence. The indicated need is for more powerful transmitters in smaller packages, longer lived power sources, and extremely sensitive antenna-receiver combinations. Very encouraging progress is being made in all three directions. For instance, quite recently the weight of the transmitter for transoceanic meteorological balloons was reduced from 230 to 12 pounds. It is hoped to cut the latter figure in half by using miniaturization techniques now under development.

Coming back to earth, and onto the ships, we are face to face with the problem of compatibility: masts, missile launchers and stacks interfere with antenna patterns; the antennas themselves are as thick as quills on a hedgehog; electronics for one purpose compete with electronics for another and the performance of both can be adversely affected by the background interference of ship's machinery. As more and more electronics are crowded into enclosed spaces, the undissipated heat becomes as damaging to components as exposure in a tropical jungle. In order to continue to add automatons to the ship's company, we must incorporate these features in design from the keel up, engineering the entire ship for the communication, warning, and missile control equipment it must carry. On the ships thus designed we can expect to find fewer antennas, fortunately, because common-working antennas—for communications at least—are becoming a reality.

But as some antennas become more efficient and more compact, others will become larger, for there is a critical necessity for very long range radar. There have been some very encouraging advances in this area, recently, although the present equipment for super-distance radar is far too bulky to be practical aboard ship.

Another field showing some very interesting progress is radio navigation. More accurate direction finders are being developed. Radio sextants have been a reality for some time and are constantly being improved. Automatic computers may presently put the navigator out of a job. There are indications that we may soon be taking "fixes," electronically of course, on satellites instead of stars.

An extremely urgent problem, one that has troubled radio engineers for over thirty years, is how to communicate by radio with fully-submerged submarines. We have had this capability since before World War II but now we are seeing significant improvements. By utilizing noise-discriminating circuits, and better match between the submerged antenna and the water medium, better reception by submarines below the surface has been achieved.

The Basic Research Picture

None of the foregoing problems, with their myriad compartments and subcompartments, are being neglected; they are all subjects for extensive basic research. The picture is so kaleidoscopic, in fact, that only a few areas may be highlighted in this brief glance ahead.

The fundamental study of electromagnetic wave propagation has a powerful assist from the upper atmosphere probing devices and techniques uncovered in the past decade. Sounding rockets have carried measuring instruments above the ionosphere, and have sent back interference-free data on solar effects, cosmic rays, and ion density. The data have been analyzed to determine the effects of various phenomena on electromagnetic propagation. This line of endeavor has been extended still further by the use of experimental satellites. The science of radio-astronomy, very actively pursued by the Navy, has discovered new sources of radiation, has uncovered new facts about the ionosphere, and has given a new dimension to receiver sensitivity.

Basic research on tropospheric propagation resulted in the discovery of a propagation duct that is apparently associated with high altitudes in areas of the tradewinds. (See page 95.) It may open up long-range channels of communication in the little used 400-MC region. Concurrently, a ten-year study of radar-pulse paths has uncovered a new method for using echoes reflected off the ionosphere. If such programs as Project Madre*—now being implemented at the Naval Research Laboratory—prove successful, we will be able to detect near-the-surface targets at great distances beyond the line-of-sight horizon. This would indeed be a breakthrough.

Again in the field of radar, the era of long-range missiles is presenting an urgent challenge to basic research. A missile thousands of miles away makes an infinitesimally small target, yet it must be acquired at take-off and tracked through the skies if we are going to intercept it or take evasive action. The requirements give us some notion of the radars of the future. They will probably have tremendously large antennas to obtain wide aperture; their emitted beams will be extremely narrow to achieve the necessary resolution; the scanning will be done electronically rather than by trying to rotate a cumbersome superstructure.

From present indications, one of the most exciting outgrowths of basic research will be in the area of new materials and components. In the former category, the new dielectrics with exotic trade names promise far more efficient and heat-resistant coatings. Various ferroelectric and ferromagnetic materials—usually in the form of crystals—have been discovered which will perform a variety of complicated electronic functions, including switching, amplification, delay, and energy storage. The interesting class of materials known as cryogenic semiconductors have fabulous potential qualities for innumerable electronic applications if only their operating temperature can be raised; at present they are semiconducting only below 15° Kelvin.*

Meanwhile, the solid-state physicists are doing amazing things in the microminiaturization of components. The past decade has seen the bean-size transistor take the place—in hundreds of applications—of the hot, complicated, and breakable vacuum tube. But even in today's most sophisticated circuits, the transistor, condenser, and resistor still have to be made separately and then connected as integral components of a given functional circuit. Within a few years this separation may be eliminated. The physicists believe they will soon be able to take a tiny block of material and—through the magic of solid-state techniques—build into it the various resistive, capacitive, and amplification *functions* desired. The resulting components will be smaller, cheaper, produce less heat, and be far more reliable; they will permit even

*Reported in March issue of SIGNAL.

*The scale of absolute temperature, with zero equal to −273.1° C.

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COMMAND CONTROL OF THE PACIFIC FLEET

pacific fleet communications

by Admiral H. G. Hopwood, USN, CINCPACFLT

"PASSING THE WORD" makes command possible. In the Pacific Fleet of the U. S. Navy, every far-flung, mobile nerve center must be responsive to the tactical and strategic needs and services of every other element of the Fleet. Naval Communications provides this vital tool of naval command.

The Navy's seagoing communication system is unique. It combines practically every means of signaling known to man from highly complex automatic coding electronic brains to megaphones.

Unlike her sister services, who have concentrated on perfecting nets of fixed geographical points, the Navy must tie together an equally efficient web joining commands that range the open sea. Each of these highly mobile segments of sea power has its own set of requirements and problems.

In the far north, an FBM submarine may be submerged, about to begin her long probe under Arctic ice. Whatever her mission, orders and information must be passed to and from her by Naval Communications.

Or, imagine a fast carrier far at sea, mainstay of a nuclear striking force, with radio her only link to parent commands. Her whip antennas are performing beautifully, when, suddenly, this elusive floating airbase heels into the wind to launch and retrieve jets. The whips are dropped to clear the deck and down goes signal strength.

The carrier task force, a key military unit geared for limited or all-out war, must receive every command accurately and rapidly under any conditions. The drop of signal strength when a carrier's whips are lowered and the dissimilar communications problems (enigmas) of the other naval units must be solved.

In the anti-submarine warfare picture the problem is primarily one of rapid coordination, because the business of detecting, localizing and attacking the elusive enemy is teamwork.

Task Force ALFA of the Atlantic Fleet has developed teamwork in Anti-Submarine Warfare (ASW) forces to a fine degree. The Pacific Fleet is moving rapidly to adopt the closely knit partnership of destroyer, helicopter, patrol aircraft, killer submarine and carrier based ASW aircraft. The key to success lies in communications. Rapid exchanges of tactical data through automatic links, positive contact with the submerged friendlies (submarines), and instant relay of command decision are necessary in this deadly game of hare and hounds.

An integral part of the Pacific Navy Command is the Fleet Marine Force. Here is added the complexity of mobile ground and air forces that move rapidly to and from sea and land carrying out their highly spe-

← COMMUNICATIONS GEAR AFLOAT

cialized warfare. As a vital member of the sea power team they have developed new tactics. Vertical development of a beachhead using airlift to cross the enemy's defense line introduces a whole sequence of problems in command communications.

Today in the Taiwan straits and all along the high seas fringes of the iron and bamboo curtains, Navy reconnaissance aircraft are on patrol. These front line eyes are in constant contact with their bases and the relay of vital intelligence must be instantaneous.

The American public will not soon forget the cowardly attack on the Navy P4M Mercator last Spring by Communist jet fighters. Freedom of the seas was violated. The minute by minute account of this incident was relayed to the White House by Naval Communications.

During World War II, the service forces developed the valuable replenishment at sea techniques. The Navy travels on its stomach as do the other services. Everything, from beans to bullets, must be delivered to combat forces without delay or interruption. Task Forces at sea must make their requirements known to supply sources. The right supplies must be delivered to the user on time and underway. Tankers and cargo ships use the ultimate in deck seamanship to make the delivery. Communications are required to place the order and arrange the rendezvous.

These forces, hampered by the uncertainties of the sea, must have communications that flow with security, reliability and speed.

Naval Communication is a living and growing system looking into the future for new methods while retaining and perfecting the best of the old. Over the years Naval Communications reflected the Darwinian process of "evolution" wherein necessity has mothered invention.

The basic skeleton of Naval Communications in the Pacific is the highly reliable, fixed geographical network of stations crossing the Pacific Ocean area. The network reaches in all directions, from Adak, Alaska, to Hong Kong, south to Australia and New Zealand, with stations in Japan, Philippines, Pearl Harbor, Guam, Midway and the west coast. With the ability to skip over intervening stations the network assumes a strength in depth and a flexibility for emergencies in peace or war. Through these centers and their receiving and transmitting stations the words of a message enter the world of automation. Skilled communications personnel translate words into punched tapes to feed cryptographic, sorting and switching transmitting devices. Then, by cable, high frequency radio, scatter, VHF/UHF radio links or landline the message flashes to other terminals of the basic Naval Communication System ready for delivery to a Fleet unit.

From the basic system, messages move to the many units of the mobile Fleet by broadcast. Broadcasting one-way traffic to the mobile Fleet units is necessary because the elusive carrier and the stealthy submarine frequently move for long periods under radio silence.

Here experience and technology meet to reach 100% reliability. The broadcast transmissions must adhere closely to time schedules; must spread over the frequency spectrum to avoid losses from the capricious dancing of the ionosphere, and must hold clear title to their radio paths to prevent interference. Communicators must be on the alert always to overcome interferences caused by nature's noises or by friendly or unfriendly electronic emissions.

To most of the Navy ships at sea, broadcast is by radioteletypewriter. For smaller units there are schedules of continuous wave (CW) transmissions. Weather is broadcast by several means, including radio facsimile. In addition, the Navy maintains a regular schedule of CW broadcasts to merchant ships on the high seas.

Ashore, the Navy's shore transmitting and receiving sites reach for the peaks of sensitivity and transmitting efficiency to compensate for the reduced effectiveness of the mobile station.

What about the submarine on lonely patrol with its special problems? The Navy's answer is in extremely long wave radio propagation. Reaching very low frequencies, around 15 KC, huge antennas hanging between giant towers and across valleys pump out slugs of radio power that hug the curvature of the earth and pierce the previously impenetrable barrier of the sea's surface.

Messages reaching the end of their route frequently find themselves translated into the colored cloth of a signalman's semaphore flags or into the piercing flash of signal light. To Marine combat units small parabolic antennas focus VHF/UHF into pencil beams of intelligence that trigger portable teletypewriters at the general's command post. UHF radio also links Marine observation and close support aircraft to the ground forces.

Research and development programs hold promise of ever greater steps. Scatter systems are already in use and the experimental moon path transmissions are proving valuable. Soon, an artificial moon will be the echo and relay station to expedite traffic and increase the flexibility of communications.

Improvements are in the offing for ship-to-shore transmissions. Improved automation and advancements in ships' antennas are being installed. Deck hands are becoming accustomed to weird and fantastic arrays of wires and baskets cluttering the topside masts and decks of their warships.

To man the shipboard communication center, there is a full division of officers and enlisted men. The quality and training of communications personnel are given the same attention and emphasis as the development and installation of the most modern communication devices. With the finest men and equipment on the job, each mobile Fleet unit becomes an integral part of Naval Communications.

From the operational characteristics of the Fleet's problems, Naval Communications has found its unique intra-service solution. But the Pacific Fleet is only one member of the national team.

As a team member of the Pacific Command, the Navy does not move alone in the vast areas of the Pacific Ocean; its hard hitting, mobile seapower remains in close contact with its teammates.

Under the Commander in Chief, Pacific, the U. S. Army, U. S. Navy and U. S. Air Force operate in closest coordination. This efficient teamwork is possible because their communications systems are inherently compatible; there is completely free transfer of message traffic.

In addition, the Navy system meets the need for close exchanges with the U. S. Coast Guard and other government and commercial agencies.

Conduct of the total Pacific Operations is achieved through the various Operational Control Centers tied together for the rapid exchange of intelligence, commands and action reports. Naval communications, while patterned for its salt water requirements and methods, is operationally compatible with the communications systems designed for the requirements of the Army and Air Force. Messages move rapidly through interservice junctions and over exclusive high speed command circuits.

Salt water command of the Pacific Navy and close coordination with sister services is possible in the split second era only through the uniquely versatile Naval Communications and the dedication of the sailor standing the watch.

NAVY ORGANIZATION FOR RESEARCH AND DEVELOPMENT

by VICE ADMIRAL JOHN T. HAYWARD
DEPUTY CHIEF OF NAVAL OPERATIONS (DEVELOPMENT)

IN THE NAVY the effective use of new weapons systems depends, to a large degree, on the ability of those responsible to exercise command and control of the widely dispersed naval and marine forces, on land and sea, under water and in the air. The arm of this command and control is the Naval Communications System. This system must be ready at all times to receive and deliver messages from any logical originator to almost any addressee.

One of my responsibilities as Deputy Chief of Naval Operations for Development, is to insure that research and development in the communications field keeps pace with the rapid progress that is being made in ships, planes, weapons systems, missiles, and satellites. Since it is true that a delay in one field adversely will affect orderly progress in others, and likewise true that a breakthrough in one will open new horizons in a second, we are striving in the Navy to see that all phases of preparedness progress in an orderly manner. To progress systematically, we must work hand in hand with industry. Our organization is designed to effectively handle research and development by our own personnel and to encourage close working relationship with industry.

The Secretary of the Navy exerts policy control over all Navy matters. Following the Secretary is the Under Secretary of the Navy whose principal responsibilities lie in the financial management of the Department and in insuring that the business administration and management of the Department is carried out in an efficient and economical manner. The Assistant Secretary of the Navy for Research and Development appears next in the organization and is directly concerned with the over-all research and development. He is responsible for policy, management, and control of Navy Department research, development, test and evaluation matters, including general management of the Navy appropriation for this purpose. He coordinates and directs the efforts of the bureaus and offices of the Chief of Naval Operations and the Headquarters, Marine Corps, in the fulfillment of research, development, test and evaluation requirements of the operating forces.

Communications equipment is simply another item of hardware required by the Chief of Naval Operations for the Navy, and the Commandant of the Marine Corps for the Marines. The Chief of Naval Operations and the Commandant of the Marine Corps are responsible for establishing requirements in terms of what is needed, when it is needed and where it is needed. The Bureaus and their associated shore activities may be looked upon as producers, and are responsible for the management of the affairs of the Navy Department in meeting requirements. These Bureaus are responsible for how the requirements will be met.

Within the Office of the Chief of Naval Operations, the Office of the Deputy Chief of Naval Operations, Fleet Operations and Readiness, formulates all the operational requirements for the Navy. These will include the generation of requirements for communications equipment which will be needed by the Navy in 1965, 1970 and so on to match the new concepts and weapons systems. The communications requirements are passed, still within the Office of the Chief of Naval Operations, to the Assistant Chief of Naval Operations (Communications) / Director, Naval Communications who in conjunction with those in my office formalizes them. My office also coordinates and integrates the over-all Department of the Navy research and development program for the Chief of Naval Operations in order to insure that the effort is continuously responsive to long-range objectives, operational requirements, fiscal limitations and advancing technology. In addition we keep the Assistant Secretary of the Navy for Research and Development advised concerning the status of the program.

After the operational requirements are developed they are sent to the Bureaus. The Bureaus perform a dual function, that is, they manage and conduct the research and development efforts and they procure the equipment. In these capacities, they may act as contracting agents if the research and development is performed by industry or they may act as management agents if work is performed at Navy laboratories or field activities.

More specifically, shipborne and shore communications requirements go to the Chief, Bureau of Ships. The requirements in their final form state, in general terms, the service to be rendered, the type of traffic to be carried and any special features that are to be considered, but not the means for accomplishment. These are reviewed in the offices of the Assistant Chief of the Bureau for Research and Development and forwarded to the Electronics Division for action. Depending upon the nature of the requirement, it would be assigned within this division to the Communications Branch, the Communications Facilities Engineering Branch or the Assistant for Marine Corps Programs. A project engineer is given the responsibility for organizing a project, monitoring its progress and reporting the results.

The decision to select a commercial laboratory, a university or a

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Navy laboratory for one or more phases of a communications development project is largely dependent upon the talents and facilities available or necessary at the time. The Navy Electronics Laboratory, San Diego; the Navy Underwater Sound Laboratory, New London; the Material Laboratory, New York Naval Shipyard; and the David Taylor Model Basin, Carderock, Maryland, all under the Management Control of the Bureau of Ships, and the Naval Research Laboratory under the management of the Office of Naval Research, have unique facilities, competent personnel and long experience in various phases of communications. In general terms, the missions of these laboratories are as follows: The Navy Electronics Laboratory covers the entire field of electronics as it applies to naval warfare. This laboratory has contributed heavily to the design, development and evaluation of communications equipment. The Navy Underwater Sound Laboratory has outgrown its name by expanding into the submarine antenna and communications field. The Material Laboratory is responsible for environmental test of communications equipment. The Model Basin is best known for hydrodynamics and aerodynamics but is materially contributing to communications by means of its computing facilities which are being expanded to one of the largest and most complete in the U. S. The Naval Research Laboratory is discussed in this article under basic research.

Contractor's Responsibility

The bulk of the technical (including environmental) testing in the past has been assigned to the Bureau-controlled laboratories. The current policy is to require the contractor to assume much of this responsibility, thus freeing the laboratories for more basic assignments.

When a project has progressed through the study, feasibility and development model stages it is usually placed with a contractor for translation into an engineering model suitable for service evaluation. Here again, the assistance of the laboratories is needed in conducting technical evaluation prior to delivery of the equipment to the Operational Test and Evaluation Force for final service testing. In many cases, under laboratory assist projects, the Commander Operational Test and Evaluation Force, Norfolk, Virginia, makes ship time available to a laboratory for technical tests. These preliminary tests serve to indicate deficiencies in the equipment or installation.

In much the same manner, the Bureau of Naval Weapons as lead bureau in air communications systems as well as electronics associated with weapons systems, processes operational requirements received from the Chief of Naval Operations. The Bureau has three primary methods of assigning its projects, namely: to the Bureau-controlled laboratories (Naval Air Research and Development Command, Johnsville, Pa.; Naval Air Test Center, Patuxent River, Md; and Pacific Missile Range, Point Mugu, Calif.), to contracted laboratories (Applied Physics Laboratories) or directly to the contractor. The names of the Bureau-controlled laboratories somewhat imply their functions. The one in Johnsville conducts research and development on aircraft communications and Patuxent River is responsible for the test and evaluation of aircraft communications. The Pacific Missile Range covers both research and development as well as test and evaluation of communications systems as related to missiles. The Bureau-controlled laboratories or the Applied Physics Laboratories may sub-contract to private firms. Responsibility for technical administration of contracts remains with the Bureau of Naval Weapons.

So far I have dealt with applied research, but of equal importance is basic research. Without this we would not be making the progress that is so readily apparent. The Navy has realized that basic research is a long-term peacetime activity, that must be stimulated, but cannot be directed. Radio communication is an excellent example of Navy research at work. At first look it appears that everything worth discovering was dug out long ago, and all that remains is to refine the art here and there. This is not true. Comparatively recent discoveries of the scatter and meteor burst communications, and moon relay prove the point.

Basic research is conducted in the Navy primarily by the Office of Naval Research although each of the Bureaus may carry on a small portion of the total basic research effort either in their own laboratories or through contracts with industry or educational institutions.

As previously mentioned, the Naval Research Laboratory at Anacostia is under the management control of the Office of Naval Research. This laboratory was established in 1923 and was initially concerned with two areas of electronics, radio and sound. Over a period of time the scope of this laboratory has considerably expanded beyond the area of physical sciences and now includes such fields as: application research, astronomy, astrophysics, chemistry, electricity, mathematics, nuclear and atomic physics, optics, radio, solid state physics and sound. Fundamental research in these diverse fields enables the laboratory to look into many facets without first having to prove that an end-use item will probably result.

When new equipment is then introduced there is always the question of reliability which is a constant and ever present companion of any research and development program. The only real product out of any such program is usable hardware and to be useful it must be reliable. Reliability extends into all the fields of warfare. Mobility, communications, surveillance, firepower and logistics are all places where a lack of reliability can cost you dearly in modern warfare. If anything, modern technical progress has made the penalty for a lack of reliability even higher than ever before in war.

A Definition of "Reliability"

At this point, I am sure a definition is in order so we understand each other on the subject. We define reliability as the quality of a device or its components which permits unfailing performance in all the environments of operations.

As I said before, the only reason for an R&D program is the production of usable and reliable hardware. The Navy has all the problems of the other services plus the fact these problems are compounded by environment, namely the sea. We fly airplanes, go beneath the sea and travel on its surface. We have amphibious operations. These all require reliability of the highest order in the equipment involved. I am sure you have the same reaction I have when you see on the front page of the newspaper the full scale picture of a missile in a raging sea of fire, unable to leave the test stand. Your disappointment is nothing compared to the results that could happen in time of war. Do not forget that war is never orderly and never goes as planned, whether one has a Bismarck or a Joint Chiefs of Staff. If one word were to describe war, it would be the word—*confusion.* So we in the R&D business must start right from the beginning and see that what we are trying to put together as a system can be made a reliable one under our previous definition. How does one really go about doing this?

If I were to give one answer to this

(Continued on page 35)

THE NAVY VIEWS THE

THE FINAL ACTS ADOPTED at the conclusion of the International Administrative Radio Conference in Geneva, Switzerland, on December 21, 1959, reflect the forward progress of communications-electronics throughout the world. Provisions for radiolocation, earth-space, radio astronomy, and maritime wide band, facsimile and special transmission systems are among the new concepts treated in the revised Radio Regulations which go into effect May 1, 1961.

The United States Delegation, headed by Commissioner T. A. M. Craven of the Federal Communications Commission, was in the forefront in developing the Radio Regulations that were adopted. The Conference was convened on August 17, 1959, and culminated in the signing of the Final Acts on December 21, 1959. The intervening months represented long hours of hard work by delegates who were faced with a tremendous task to be accomplished in a relatively short time. It is noteworthy that the Conference as a whole was determined to accomplish a first-class engineering job, and that all delegations were professionally well qualified for the task at hand.

From a Navy standpoint, the International Administrative Radio Conference is another reminder of the importance of international relations which are constantly stressed to naval officers throughout their careers. It is traditional to the nature of sailormen traversi[illegible]d's seas that they come in [illegible]h the authorities of othe[illegible]. This tradition of parti[illegible] international discussion w[illegible]ed at Geneva as the Navy [illegible]articipated in the preparat[illegible] but also provided repres[illegible]n the U. S. Delegation t[illegible]ernational Administrative [illegible]ference itself. This is conti[illegible]ng history of naval partici[illegible] such conferences, in wh[illegible]al representatives have [illegible]ved a major role.

The interes[illegible]Navy in telecommunicati[illegible]ied indeed, as naval operati[illegible]onducted not only on the [illegible]nder the seas, in the air, a[illegible]d. The Navy situation is [illegible]e most users of telecommu[illegible]perate in only one, or poss[illegible]f these categories. In th[illegible]e operate in them all. Al[illegible] naval operation or functi[illegible]rted by Naval Communicati[illegible]aval Electronics. Frequen[illegible]uired not only for exchange[illegible]s but also for navigational [illegible]rs, data systems, teleme[illegible] weapons systems.

Because of[illegible]es in the state of the art in [illegible]ications since the last Inte[illegible]adio Conference, held a[illegible]City in 1947, the Internati[illegible] Regulations adopted then[illegible]need of revision. These [illegible]re marked by the common[illegible]tance of the "jet age," the "missile age" and the appearance of the "space age." From a military and naval viewpoint, we have since 1947 changed from guns to missiles, from conventional weapons to nuclear weapons, and, in the air, from subsonic to supersonic speeds. Other advances include the advent of data communications systems, satellites, the use of ionospheric and tropospheric scatter systems, facsimile, new electronic navigational aids and radio astronomy. Thus, it was to the military interest, as well as to the civil interest, that the Radio Regulations be brought up to date.

New Table of Frequency Allocations Adopted

One of the major accomplishments of the Radio Conference was the adoption of a new Table of Frequency Allocations. The upper limit was extended from 10,000 MCS to 40,000 MCS. To those accustomed to reading the Atlantic City Table, some readjustment will be required. The Table is presented in such a manner as to indicate the relative priority of radio services more clearly than in the Atlantic City Table. In the Table itself, this priority is indicated by different kinds of type—i.e., by the use of capital letters, italics, etc. Allocations are made to radio services as before but they are broken down into primary services, permitted services, and secondary services, each indicated in the Allocation Table by a

INTERNATIONAL ADMINISTRATIVE RADIO CONFERENCE, GENEVA, 1959

by COMMANDER L. R. RAISH, USN
HEAD, FREQUENCY ALLOCATION SECTION, PLANS AND POLICY BRANCH, OFFICE OF NAVAL COMMUNICATIONS

different kind of type. In addition, standardized terminology is used in the footnotes to the Table to clearly indicate the intention of the Conference at the time the footnote was adopted. In general, the Allocation Table is not changed significantly below 27.5 MCS. Above 27.5 MCS there are changes to reflect the new concepts and changes in communications-electronics usage. Fortunately, however, most of these changes will have little impact on most U.S. national allocations now in force.

Amateurs

The U.S. Delegation led the way in protecting the amateur interests at the Conference. There was extreme pressure to reallocate amateur bands, particularly below 30 MCS, to other services. The Geneva discussions were, in reality, an extension of the 1947 discussions at Atlantic City, where several countries, mostly European, initially wanted to reallocate amateur spectrum space to provide for other services, primarily broadcasting. The U.S. Navy interests in amateur operations are well known and the success of the U.S. Delegation in negotiations to preserve the "ham bands" is particularly gratifying, as it must be to amateur enthusiasts in many countries of the world.

Radionavigation

A number of frequency bands are now allocated to the radionavigation service to accommodate the latest electronic advances in this service. The Table of Frequency Allocations does not spell out, as a rule, the trade name for any particular navigational system; however, the allocation of certain bands for "radionavigation" is recognizable to those interested as being identified with specific systems. For example, the allocation of 90-110 KCS for radionavigation makes possible the accommodation of the LORAN-C system. Allocations to radionavigation between 1800 and 2000 KCS accommodate the standard LORAN system. The allocation of 960-1215 MCS for aeronautical radionavigation provides for the DMET portion of the VOR/DMET system. The 13250-13400 MCS allocation to aeronautical radionavigation will accommodate new doppler navigation aids. The foregoing are some of the bands allocated for radionavigation purposes. Several other bands are also allocated to accommodate either existing or planned radionavigation systems.

Radiolocation

One of the most significant changes in the new Radio Regulations was the agreement to recognize the radiolocation service. Radiolocation is defined in the Regulations as "radiodetermination used for purposes other than those of radionavigation." A separate radiolocation service was originally a United States concept that was adopted by the Conference after thorough discussion to differentiate between those electronic devices used for radionavigation purposes and those used for other than radionavigation purposes. It was the U.S. view that devices involved in safety-of-life operations should have protection from other devices not used for such purposes. As one of the biggest users of electronic devices for all purposes, this was of great interest to the Navy. Thus, a study of the new Table of Frequency Allocations will reveal that a number of bands are now allocated to radiolocation. The allocation of separate frequency bands for radiolocation and radionavigation is of great significance to equipment manufacturers and designers.

Aeronautical

The Final Acts contain many provisions of benefit to the aeronautical services. Many of these, of course, are covered above in connection with the discussion of radionavigation. Additionally, provisions were made to retain the aeronautical allotment plans for the high frequency bands without significant change in the form of appendices to the new Radio Regulations. The aeronautical (OR) plan, which, in the United States, is of primary concern to the Navy and Air Force, is virtually unchanged. The aeronautical (R) plan was amended to reflect new requirements, particularly to accommodate air routes involving the USSR. The Conference recognized, however, that the aeronautical plans originally drawn up in 1949 may require revision in the future to take account of the changing factors in international aviation. To this end, the Conference adopted a resolution that the Administrative Council of the ITU should convene an Extraordinary Administrative Radio Conference, when deemed appropriate, to review the aeronautical mobile service plans and the provisions of the Radio Regulations associated therewith before the next Ordinary Administrative Radio Conference. It is still too early to decide when such a Conference will be held.

Maritime

The maritime portions of the Radio Regulations came in for a thorough review, which was closely followed by the Navy throughout the Conference. The exclusive high frequency maritime mobile bands were retained as such in the Table of Frequency Allocations but substantial reallocations were made within them. The Conference, after exhaustive discussion and deliberations, made allocations of maritime mobile spectrum space to accommodate the changing requirements of the maritime service. Provisions were made for "wideband, facsimile, and special transmission systems," for ship single sideband telephony, and for double sideband voice calling frequencies for the maritime radio telephone service. The designations of "passenger ship bands" and "cargo ship bands" have been replaced by bands identified for "high traffic ships" and "low traffic ships." The "low traffic" bands are the former cargo ship bands, with no change other than in the title. The "high traffic" bands are the remaining portions of the former passenger ship bands which were reduced to accommodate the "wideband, facsimile, and special transmission systems, ship single sideband telephony, and double sideband calling. "High traffic ships" are defined as including passenger ships, whaling factory vessels, tankers above 40,000 tons, and cargo ships above 12,500 tons.

The existing high frequency allotment plan for coast radiotelephone stations and accompanying duplex channeling plan were modified by compressing the channels sufficiently to add one extra double sideband telephone channel. It was the opinion of the Conference that there have been sufficient advances in the art to permit narrowing the maritime radiotelephone channels without derogating the service to the public. The coastal radio telephone allotment plans and the duplex channeling plans are being appended to the new Radio Regulations in order to retain their identity.

Radiotelephone

The Conference manifested considerable interest in the introduction of single sideband techniques in the maritime radiotelephone service. Two actions were taken—namely, (1) the reallocation of a portion of the spectrum space from the former passenger ship bands for ship single sideband telephony, and (2) provision in the Radio Regulations for the utilization of single sideband on the maritime radiotelephone channels presently allocated for double sideband. The latter provision is intended to assure a compatible approach to the use of single sideband in the maritime radiotelephone service by the member nations of the International

Telecommunication Union (ITU).

The assignment plan for maritime coastal radiotelegraph stations approved at the Extraordinary Administrative Radio Conference, Geneva, 1951, was considered to have served its purpose and is to be absorbed into the new International Frequency List. The coastal radiotelegraph plan differs from the coastal radiotelephone plan in that the former is a frequency assignment plan to stations whereas the latter is an allotment plan to countries. Thus, as regards the coastal radiotelegraph service, the notification and registration procedures to be administered by the International Frequency Registration Board will apply upon the effective date of the new Regulations.

Provision is made for maritime VHF radiotelephony in the 156-174 MCS band by the inclusion of a special table of transmitting frequencies for radiotelephony in the international maritime mobile service as an Appendix to the new Regulations. Some delegations strongly urged a world-wide priority status for the maritime mobile service in those frequency bands covered by The Hague Agreement on this subject. A compromise was reached that protects the land mobile allocations in the 156-174 MCS band in the United States, at the same time recognizing certain specialized types of marine operations not provided for in the international plan.

Earth/Space and Space Services

The Conference had a difficult time agreeing to allocations for earth/space and space services, largely because only two countries seemed to be directly interested. Attempts to make allocations on a world-wide basis were difficult to negotiate because most countries did not have earth/space or space programs of their own and, thus, did not feel inclined to jeopardize existing operations to accommodate a service for which they have no present or foreseeable need. The USSR, which, along with the United States, is primarily interested in the earth/space and space services, took the position that it was premature to earmark any frequency bands for this service. The discussions at the Conference resulted in a decision to make frequencies available for earth/space and space research and that allocations of frequencies for operational use by space vehicles and satellites would be premature at the time. The Conference further agreed on a recommendation that an Extraordinary Administrative Radio Conference be convened during 1963 for the purpose of examining the technical progress in the use of radio communications for space research and to decide on allocation of frequency bands essential for the various categories of space radio communications. This conference would also consider whether there would be a continuing need for allocation of frequency bands for space research, and revise the Radio Regulations as may be necessary. The Administrative Council of the ITU will make the final decision on whether there is sufficient justification to convene a special conference in 1963 and will review the situation during its 1962 and 1963 ordinary sessions. Considering that only two countries were actively interested in space and earth/space matters, the Conference did well to allocate as many frequency bands as it did for research in earth/space and space matters.

Radio Astronomy

Upon arriving in Geneva, the U. S. Delegation learned that there was considerable interest throughout the world in radio astronomy. The original U. S. proposal for frequency allocations envisaged allocation of one band (the hydrogen line at 1400-1427 MCS), with the understanding that the whole spectrum would be protected for radio astronomy in designated areas—for example, in the area around Green Bank, West Virginia, in which the Navy has considerable interest. However, such a concept was not acceptable to the Conference because several countries, particularly the Netherlands and United Kingdom, pointed out that their countries were too small to provide silent areas for the radio astronomers and that international agreements would be necessary. They desired to establish several "windows" in the spectrum that would be free from man-made noise. During the Conference, the U. S. Delegation made a thorough study of all stated requirements for radio astronomy and revised its position, to enable agreement to be reached on the decision to designate several individual frequencies for radio astronomy as well as the 1400-1427 MCS band. Further, there are several provisions in the Allocation Table by footnotes for additional radio astronomy frequencies on a limited basis. This action was necessary because many of the radio astronomy requirements were in such congested areas of the spectrum that world-wide allocation was unrealistic at this time. Looking ahead, the Conference also adopted a recommendation that administrations, when preparing for the next Administrative Radio Conference, should consider further the question of frequency allocations for the radio astronomy service. This recommendation points particularly towards allocations in the ranges 37-41 MCS and 606-614 MCS. In this same recommendation, the Conference draws attention to the fact that sites for radio astronomy observatories should be selected in areas as remote as possible from sources of radio interference.

Master International Frequency Register

The Conference devoted considerable time to the development of procedures for use by the International Frequency Registration Board for the establishment of the new Master International Frequency Register. The Conference agreed in Article 9 that: "Any frequency assignment . . . to a fixed, land, broadcasting . . . earth, radionavigation land, radiolocation land or standard frequency station, or to a ground-based station in the meteorological aids service, shall be notified to the International Frequency Registration Board.

(a) if the use of the frequency concerned is capable of causing harmful interference to any service of another administration; or

(b) if the frequency is to be used for international radio-communications; or

(c) if it is desired to obtain international recognition of the use of the frequency."

The foregoing is a projection of a part of the Atlantic City Administrative Radio Conference of 1947 where the concept of an engineered International Frequency List was adopted. Experience since 1947 has proved that development of a completely engineered International Frequency List is not feasible. The U. S. Delegation successfully advanced a threefold position—namely, that the engineered lists agreed at the Extraordinary Administrative Radio Conference should be retained, that the evolutionary procedure for the unplanned bands below 27.5 MCS be continued, and that future emphasis be placed on more effective use of the frequency spectrum.

The Conference took actions to improve and strengthen the International Frequency Registration Board (IFRB) and to improve its internal workings. Also agreed were detailed procedures for the examination of notices, the transfer of frequency entries from the existing Master Record to the new Master Register, and the recording of new assignments. It is

anticipated that the new Master International Frequency Register will became effective on 1 May 1961, and that the IFRB shall maintain it, preferably by means of a mechanical system.

Of particular significance in the procedures governing the IFRB are provisions for placing emphasis on the actual uses of the frequency spectrum by members of the ITU. In the future, an early registration date will be only one factor of many that the IFRB will consider when deciding frequency assignment matters. The Conference also adopted procedures intended to develop on a gradual basis an engineered plan for the high frequency broadcasting bands. In addition, the IFRB was given the difficult task of examining and preparing high frequency broadcasting schedules for each seasonal propagation period. These broadcasting schedules will be published well in advance and recapped annually.

New IFRB Elected

The IFRB was established as the result of actions of the International Telecommunication Conference of Atlantic City, 1947. The Geneva 1959 Conference agreed to retain the eleven-member board which will serve as an independent international body for the management of the radio frequency spectrum. Elected to serve on the IFRB and regions represented are:

The Americas—
- Mr. John Gayer (USA)
- Mr. Fioravanti Dellamulla (Argentina)
- Mr. Alfonso Hernandez Cata (Cuba)

Western Europe—
- Mr. John A. Gracie (UK)
- Mrs. Rene Petit (France)

Eastern Europe and Northern Asia—
- Mr. Mieczyslaw Flisak (Poland)
- Mr. Ivanovich Krasnosselski (USSR)

Africa—
- Mr. Noel Roberts (Union of South Africa)

Asia and Australasia—
- Mr. M. N. Mirza (Pakistan)
- Mr. Shin-Ichi Hase (Japan)
- Mr. Tai-Kuang Wang (China)

Future Planning

The Conference recognized that future action may be required on several matters of international significance. Most pressing problems concern policies for the future use of the high frequency spectrum. A Resolution was adopted for the establishment of a Panel of Experts to devise ways and means of relieving the pressure on the bands between 4 and 27.5 MCS. This Panel will work under the Administrative Council, which will decide in consultation with Administrations the action to be taken on any report prepared. The Conference also adopted Recommendations concerning the use of the high frequency spectrum. It is anticipated that the cognizant authorities within the U. S. will initiate national action required by the foregoing.

The changing aeronautical pictu was recognized by the Conference b the adoption of the Resolution mentioned in the aeronautical section this article concerning an Extraordnary Administrative Radio Confeence to review the Frequency Allo ment Plan for the Aeronautical M bile Service. The Conference als adopted a Recommendation for a Extraordinary Administrative Radi Conference to be convened in 196 to consider frequency bands for spac radiocommunication purposes subje to Administrative Council review a to need for such as its 1962 and 196 sessions.

Conclusions

The results of the Internationa Administrative Radio Conference in dicate that the U. S. Delegation wa able to participate effectively an constructively toward reaching agree ments which were acceptable to th eighty-three powers signatory to th Final Acts of the Radio Conference Since the U. S. has an enormous re quirement for radio frequency alloca tions and a vital interest in all of th Radio Regulations, the effectivenes of U. S. participation required ver careful planning with maximum con sideration for other users. To Com missioner Craven, as Head of th U. S. Delegation, we give a heart "well done" for representing th U. S. in such an outstanding manner The Navy is proud to have had mem bership on his Delegation.

The Plenipotentiary Conference

THE PLENIPOTENTIARY Conference of the ITU was convened on October 14, 1959, in Geneva, and ran concurrently with the last part of the International Administrative Radio Conference. Mr. Francis Colt de Wolf, a veteran of many ITU Conferences, headed the U.S. Delegation. He was assisted by Commissioner Rosel Hyde, of the Federal Communications Commission, who acted as Vice-Chairman of the Delegation. The Plenipotentiary Conference, as the supreme governing body of the ITU, adopted a new International Telecommunications Convention on December 21, 1959. The new Convention becomes effective on January 1, 1961, and on that date will replace the Buenos Aires Convention of 1952, which is currently serving as the governing Constitution of the ITU.

Significant actions were taken concerning political, as well as budgetary, matters. Recognizing the increased world interest in communications-electronics, the Plenipotentiary Conference acted to provide broader representation in the world's telecommunication affairs by expanding the Administrative Council of the ITU from 18 to 25 countries. Also voted was an increase in the ITU budget, starting with a total of 9,000,000 Swiss francs in 1960 to be raised in increments to a total of 12,200,000 Swiss francs in 1965. Budgetary allowances were also made for a number of meetings scheduled to take place in the next few years.

The Plenipotentiary Conference decided that the ITU should henceforth administer ITU projects carried on under the United Nations Technical Assistance Programs. In the past, the United Nations itself administered such programs on behalf of the ITU. Taking account of the communications-electronics requirements of new and developing countries, it was agreed that the ITU should play a more active role in the UN Specia Fund for Economic Development. In the future, as regards technical assist ance, the International Radio Con sultative Committee (CCIR) and In ternational Telegraph and Telephon Consultative Committee (CCITT) o the ITU are committed to assist coun tries having underdeveloped telecom munications systems.

Mr. Gerald Gross, the Acting Sec retary-General of the ITU at the tim of the Conference, and an America national, was elected to serve as Sec retary-General until the next Plenipo tentiary Conference. Mr. Manohar Sarwate, of India, was elected to serv as Deputy Secretary-General.

The next Plenipotentiary Confer ence is expected to be convened i Switzerland, at the invitation of th Swiss Government, during 1965. Thi will mark the centennial of the ITU which was originally founded in 186

THE FREQUENCY SPECTRUM JUST CAN'T TAKE IT

by W. DEAN, JR.
Frequency Allocation Section, Plans and Policy Branch
Office of Naval Communications

THE RECRUITING PLACARDS which appear in front of Post Offices throughout the country advise the public of the fact that the U. S. Navy of today is a supersonic, atomic and electronic Navy. These three adjectives define prime areas within which effort is being made to ensure that the U. S. Navy will continue to serve as a major deterrent to world conflict and as an ever-ready offensive striking force should the need arise.

We are all familiar with the supersonic aspect whereby aircraft fly in excess of a thousand miles an hour and missiles travel at heretofore unheard of speeds. Examples of the atomic Navy are readily apparent by the operational employment of nuclear powered submarines such as the *Nautilus* and *Seawolf*. The purpose of this article is to concentrate on certain aspects of the electronic parameter of the modern Navy—that is, the impact upon the radio frequency spectrum. Radio frequencies enter into the over-all electronic picture by virtue of the fact that they are a common denominator, in that any equipment which emits a radio frequency must operate in the radio frequency spectrum.

Radio frequencies are vital to the conduct of modern warfare. The Navy considers the finite usable radio frequency spectrum to be one of the nation's most valuable resources. The term "radio frequencies" encompasses all radiations of electrical energy which have escaped into free space. From a military standpoint, treatment of this subject encompasses communications, radar, guided missile control, navigational aids, satellite and space electronic configurations, and all other devices which emit electromagnetic waves between 10 KCS and 30,000 MCS.

In order to maintain a state of operational readiness adequate to meet any potential threat to the United States as well as support international commitments, it is necessary that U. S. military services have the capability of employing modern weapons systems on virtually a global basis. This capability is an absolute prerequisite in the case of far-flung naval forces. The weapons systems involved, for which electronics normally provides the nerve center, are vital to the satisfaction of operational requirements incident to such paramount needs as anti-submarine warfare, air defense, the control of major strike forces, and the maintenance of an immediate reaction capability for potential and actual trouble spots wherever occurring. Such requirements not only necessitate the provision of radio frequencies to operate electronic systems such as radars and navigational aids, but also demand reliable communications on a 24-hour basis throughout the widespread areas of the world where U. S. forces may be required to operate. One has only to reflect upon the speed and devastating consequences of modern warfare to realize that the nation cannot afford to be in a position of having an inadequate military communications-electronics capability. Recognition of the need for maintaining a well stocked communications-electronics arsenal is evidenced by the proportion of the output of the electronics industry of the country currently involved in the military effort and the proportion of all electronic engineers now engaged in some degree of work on military programs.

Increased operational requirements, coupled with the limitations dictated by size and weight, particularly in the missile and satellite areas, place burdens of considerable magnitude upon the usable radio frequency spectrum. The maintenance of operational control of high speed aircraft, the adoption of guided missiles systems as primary means of armament, the introduction of the satellite and space complex, and the ever-pressing requirements associated with radar detection serve to illustrate the nature of this impact. Whereas a few electronic equipments would have sufficed for the satisfaction of a given operational requirement in World War II, it may now be necessary to employ literally dozens of equipments within the confines of the same environment.

To meet the foregoing needs and provide for U. S. participation in the constant struggle of electronic measures and countermeasures, military electronic devices must, perforce, embrace virtually the entire usable radio frequency spectrum. The satisfaction of such requirements can be realized only by the application of rigorous circumspection to ensure that every kilocycle available for military purposes is employed by existing or soon-to-be-available electronic hardware or for research and development looking toward the availability of new means of meeting military requirements. Extensive operations are maintained throughout the usable radio frequency spectrum, beginning with very low frequencies for naval shore-to-ship communications and progressing to extremely high frequencies, where other specialized applications are made, such as for navigational aids, identification systems and telemetering devices. No problem would exist if the radio frequency spectrum were either limitless or unoccupied by other users. Such is not the case, however, and military requirements must be satisfied within

the framework of established national and international provisions which regulate the vital commodity, radio frequencies. This requirement for compliance is recognized as necessary, since all needs, both civil and military, must be met within the one finite radio frequency spectrum. Such compliance, however, places stringent limitations upon the military services in the satisfaction of operational requirements. These limitations take the form of confining certain electronic operations either to training areas beyond interference range of continental U. S., resorting to time-sharing wherein certain operations can be conducted only on "off-hour" basis, or the application of complex coordination procedures to ensure that certain military operations are conducted on a noninterference basis to services which operate in accordance with applicable tables of frequency allocations. The magnitude of the effort required to constrain military operations within such limitations may be more readily appreciated when it is realized that since 1947, the ever-increasing reliance of the military services upon electronics has had to be accommodated within the framework of an International Table of Frequency Allocations which was conceived in an atmosphere which did not anticipate subsequent international developments.

Within the Navy, the responsibility for the procurement, assignment, and protection of all radio frequencies employed by U. S. Naval units rests with the Chief of Naval Operations, who has delegated the task of carrying out this responsibility to the Assistant Chief of Naval Operations for Communications. This responsibility has many facets, such as:

a. The determination of the radio frequencies necessary to support naval communications.

b. The assignment of radio frequencies to communications circuits or services, radio stations, units of the operating forces, or specific electronic equipments.

c. The protection of radio frequencies from interference, actual or potential.

d. Participation in military, national, and international negotiations relative to frequency allocation matters.

e. The promulgation of information on radio propagation predictions and conditions.

f. The determination of the frequencies in the electromagnetic spectrum necessary for the operation of the various electronic devices employed by the Navy.

g. And last, to provide guidance to developmental agencies as to the appropriate frequency bands for the development of new communications-electronics equipment so as to ensure that operational compatibility with established services may be realized.

The problem of ensuring that frequency assignments for military electronic devices are effected in such a manner as to attain compatibility, both among the military services and between the military and other users of the frequency spectrum, is increasing in complexity. This difficulty is proportional in degree to the expansion in the use of electronics by all interests. In addition to the requirements of the over-all preparedness program, commercial interests have recognized the advantages to be gained by the manifold applications of electronics. In the portion of the spectrum below 30 MCS, propagation conditions making this portion particularly suitable for long-range communications, the constant objective is to achieve increased capacity in a minimum of spectrum space. Competition is intense for frequencies of this order; however, techniques developed as a result of experience during the last half century afford a degree of flexibility and capacity in the satisfaction of requirements. Expansion within the United States since 1945 in the use of very high frequencies and above has been almost beyond comprehension. In this portion of the spectrum, where radio frequencies are most suitable for line-of-sight purposes, experience has shown that the requisite flexibility and capacity do not exist. Concerted effort in this area is needed toward providing relief if serious consequences are to be averted.

So far as the Navy is concerned, the basic problem in the radio frequency field is how to get "more combat capability per dollar per kilocycle." Attainment of this goal can be realized only through the exercise of careful planning in the present and planned use of the spectrum. As previously mentioned, practically everybody is expanding his use of radio electronic equipment, but the radio frequency spectrum refuses to expand correspondingly. The point has been reached, if not passed, where the finite limits of the radio frequency spectrum cannot satisfactorily accommodate additional operational requirements unless the utmost care is exercised by all who have responsibilities with regard to development and use of electronic equipment.

The ramifications which contribute to the problem of spectrum saturation are diverse and embrace ever facet of the electronics field—i.e., re search, component development equipment production, operationa employment and frequency manage ment. Three parameters are con sidered to be of particular signifi cance—(a) the nature and magni tude of operational requirements, (b the state of the radio art, and (c) th limitations of the usable radio fre quency spectrum.

The limitations imposed upon th military services by the lack of suit able radio frequencies have previous ly been treated. Military operationa requirements are in a constant stat of expansion and adjustment as dic tated by changing tactical concept and the technological advancement of the United States and other countries. The very nature of a give operational requirement may dictat the frequency to be employed. I long-range radar detection is the primary objective, certain frequency orders are dictated. On the other hand, if high resolution is the prime requisite, other frequency orders must be employed. Size and weight limitations, plus the number and types of operating units involved, also contribute to the determination of the optimum radio frequency for a given requirement. The quest for higher output powers, the need for more sensitive receivers, and the time factors involved in treating projects on a crash basis within established funding levels, serve to illustrate the ramifications involved in the satisfaction of operational requirements.

The state of the radio art, particularly as regards transmitter flexibility and tuning capability, the adequacy of test equipment, and the difficulties inherent in transmitter and receiver characteristics, must be considered in equating military communications-electronics needs. The engineering problems involved in endeavoring to accommodate the simultaneous operation of large quantities of electronic emitters and receptors in close proximity within the same radio frequency band at times appear almost insurmountable. This situation is particularly acute in the case of Navy ships wherein large numbers of electronic equipments must be accommodated within extreme space limitations to meet the needs for communications, navigation, missile control, detection, and identification. Improvement is needed in such areas as intermodulation products, extraneous radiations, and receiver image responses, to name a few. One of the most critical needs is for the develop-

(*Continued on page* 35)

the importance of communications-electronics in weapons systems

by REAR ADMIRAL PAUL D. STROOP, USN
CHIEF, BUREAU OF NAVAL WEAPONS

THE FORMATION OF the Bureau of Naval Weapons was an important step forward in the solution of the problem of basic communications. The integration of the Bureau of Ordnance and the Bureau of Aeronautics by an efficient recombination of offices has decreased the channels of communications without significant increase in span of control of the Chief of the Bureau. In the communicator's language, the Chief of BuWeps has reduced, at his level, the number of circuits for the total job of weapons planning, design and production, and at levels below him has still further reduced cross-coupling and short circuits in his feeder channels. He has fewer paths and more noise-free exchange of communications. These are basic criteria for improvement and lead naturally into expanded capacity for useful work whether the area of relation is in administration or actual performance of a "black-box" equipment array.

This significant advance has its direct parallel in the development of modern Navy communications and its application to fleet command and tactical problems. As the tempo of combat increased and reaction time shortened, older communications networks, although adequate for the slower moving situation of World War II and Korea, became overloaded. This has necessitated the combination of functions, a regrouping of the data systems providing tactical inputs and the development of machines and man-machine combinations capable of operating at satisfactorily efficient speeds for each element.

Man is an effective machine from the standpoint of data assimilation, storing and decision-making. However to meet the requirement for response to decreased reaction time, he should keep his decision-making channel capacity free for essentially this function only. He must, therefore, be supplemented by machines which perform the routine analysis at tens of thousands of times his normal capacity. The function of a machine is to act upon and smooth raw data to fit man's decision-making bandwidth and complement the man by being under his intelligent control for maximum cooperative effectiveness.

The communications-electronics plan of the Navy thus has been to optimize this relationship at all command levels and strike for the greatest combined efficiency of utilization of this combination in the tactical environment. It is important to note at this point that the Navy Combat Director Function, ashore and afloat, has as its objective: "To provide commanders of forces ashore and afloat and commanding officers of ships with the capability to process, correlate and evaluate strategic and tactical data, to direct their operations in time to meet a threat and to coordinate the various weapons systems in a combat environment. This will be done by achieving a high degree of automation in data processing, exchange and evaluation through use of computers and digital data processing techniques in general-purpose combat direction systems."

The integration of a weapon system into a modern tactical combat direction complex is therefore primarily a communication problem. Solution of this problem involves a consideration of the kinds and quantities of information to be transferred, and the range, speed and security requirements. The requirement may extend from short-range, plain-language, telephone-circuit to high speed, pulse-coded, long-range, radio links. Digital computer assistance in reducing tactical data and in preparing messages is challenging the capability of existing communication systems.

The basic task of combat direction has not changed for centuries. Information passed over the two-way link between weapon system and command can be described in more or less the same general terms that have been

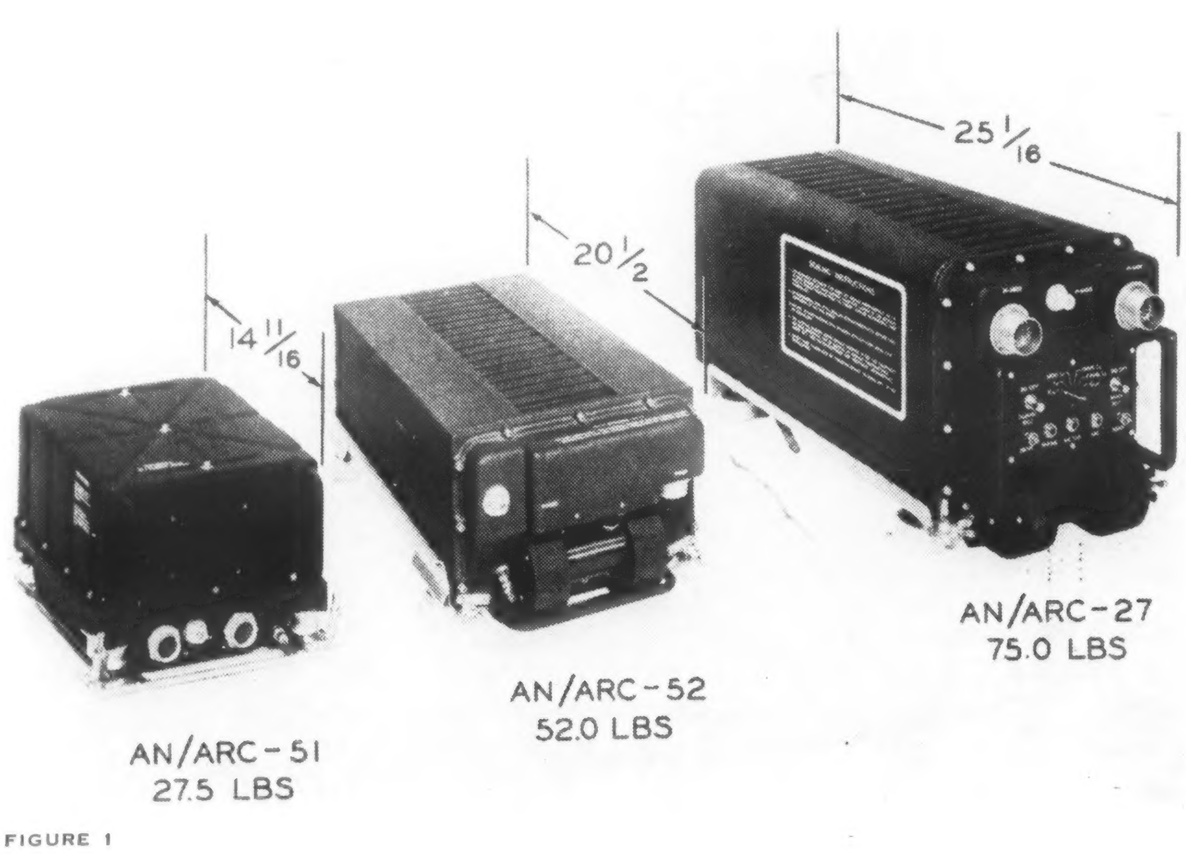


FIGURE 1

useful throughout the history of tactics. The weapon system passes a contact report to command, together with an evaluation of the target capabilities and threatening attitudes. Command must also be advised of the status of the weapon system, i.e., its present capability and current commitments. Finally after a weapon system commitment, command requires information of weapon effect. For its part command must direct the initiation of weapon system fire or advise open-fire criteria. It may assign targets or delegate that authority.

In addition to these requirements for external communication there is a requirement for weapon system internal communications. The nature of the internal communications of a weapon system is widely variable but can be related generally to the flexibility required in the post launch performance.

In the case of purely ballistic weapons there is generally no post-launch communications requirement; but in the other extreme, a manned weapon, a tremendous flexibility of the manned weapon is its primary justification, and to be fully exercised requires some external control.

To meet these general tactical communications requirements in the probable warfare environment of the next ten years is a major task of the Bureau of Naval Weapons and the Bureau of Ships. The design of communications-electronics hardware is based on both a prediction of the warfare environment and a knowledge of the corresponding characteristics of the weapons to be controlled. What changes in these elements are demanding improved communications?

If one parameter can be singled out as the source of the change in warfare environment it is speed. Technological advances in weapons have increased the speed with which an attack can be delivered. Stated in another way, the time between an aggressor's will to attack and culmination of the attack have been shortened by an order of magnitude from World War II conditions. Not the least cause of the shortened time is improved communications.

Tactical Command Direction

Tactical command direction in order to be competitive in this environment must bring its full fire power to bear in a much shorter time than ever before. The shoot-look-shoot methods of previous years are generally inadequate in both offensive and defensive operations. The rate of collection of target intelligence has been improved but the speed of the human has not. He will take just about as long to make a command decision today, given the same input intelligence, as he did 50 years ago. The only productive approach to the problem of reducing the decision time of command appears to be processing of raw intelligence so as to present a smaller quantity of more valuable intelligence for command decision.

The technique of the Navy in real-time intelligence processing has been to leave only those decisions to command which can benefit by refined human judgment. Fortunately, it has been found that command decisions are based largely on stereotyped mathematical calculation and very fundamental logic tempered with a small but important quantity of human judgment. For example, consider the situation in which a commander is confronted with a single target and several weapons with which to engage it. He will assign the weapon which will allow the target to survive for the shortest time. A simple speed, time and distance problem indicated the preferred weapon. If this problem were solved by a computer and the result presented to the commander for approval, he could apply whatever subtle consideration he might wish or simply execute the assignment on the machine recommendation. Further, he might under press of battle conditions waive his prerogative of approval to gain even faster execution knowing that the machine was employing rules in consonance with his normal decision making processes. Real time digital computers are now available to filter the tremendous amount of data which modern sensors can acquire. These same machines can perform a wide variety of routine calculations and make simple logical decisions based on the human experience which is built into them. The speeds of these tactical data processing machines are offering information for transmission between command and weapon system, and between weapon system and weapon at an unprecedented rate. Communications cannot be allowed to bottle-neck this essential exchange.

The several major problems of communications are to handle the available information with the highest order of reliability in a minimum bandwidth, at suitable speed and at maximum security. It must do this job with even smaller equipment weight and volume to compensate for the increased capacity requirements.

Communications provides major inputs to the computer complex as well as handling the buffered output of the computer to furnish interference-free and operationally jam-free transmission of information to fleet dispositions within operational range.

Advantage is taken of the most modern techniques such as single side band communications where possible. From applications of these techniques is derived a high degree of freedom from transmission path vagaries which coupled with frequency change flexibility leads to optimum usefulness under difficult operational conditions.

Future of Systems

The question now arises as to the future of these systems. Many elements of the problem are as yet only partially solved. Designers and producers are continually striving for increased speed of operation, simplified forms of data presentation for the human operator or commander, and better data utilization and processing. Ingenuity is being taxed to improve reliability of individual equipments and sub-systems and to achieve a better understanding of logistic requirements. The whole field of radio frequency incompatibility is being treated seriously so that large and powerful systems, having an impact over great geographical areas, can live with themselves and other cooperating systems. A great effort in coordination, planning and technical execution is being laid down to accomplish these ends. The Tactical Commander will be given virtually complete freedom for weapons utilization based on accurate knowledge of the threat and his own weapon's status, availability and capabilities through the medium of communications-electronics.

A hint of some of the progress can be had by observing the steady reduction in factors of size, weight and improvement in performance in a communications-electronic sub-system shown in Figure I. Each redesign approach has resulted in improvement to each of these factors by about two to one over the first and succeeding models. While this may or may not be possible in all areas of sub-systems, modern technology is being exploited to the fullest to achieve simplification and vastly improved performance.

All this could not be done without the advances in planning and execution supported by the efficiency provided in the new Bureau of Naval Weapons organization. Weaponry is now finally under a single roof with the old aggregation of controls reduced to a single entity. The future will demonstrate the wisdom of this change as the importance of communications-electronics continues to grow and be felt at an ever increasing pace.

SUBMARINE COMMUNICATIONS

by REAR ADMIRAL LAWRENCE R. DASPIT, USN
COMMANDER SUBMARINE FORCE, ATLANTIC FLEET

FORTY-EIGHT YEARS ago a small submarine—the SS E-1, or *Skipjack*—did a rather noteworthy thing while operating off Newport, R. I. She transmitted and received radio messages at a distance of four miles. The feat of this submarine—the first to be equipped with radio—marked a tremendous advance over previous communications systems. Through the years submarine radio facilities and capabilities have increased many times over. Today the submarine radio communications network extends around the world.

In all of my remarks in this article the difference between a conventional submarine and a nuclear powered submarine is chiefly one of degree, the extent of the difference depending upon the particular units involved and the weapons available at the time. Usually this difference is heavily in favor of the nuclear but this is not necessarily always true.

Naturally, the submarine is reluctant to do anything to disclose its presence and to bring on an intensive search by the enemy, a search which would make the performance of its mission more difficult. For this reason it prefers to run submerged—to make very short, infrequent periscope observations and to expose only an air pipe (snorkel)—rather than to operate on the surface. To further hinder disclosure of its position, the submarine prefers to depend on passive detection of the enemy's radar by electronic countermeasures (ECM), rather than to use its own radar.

Surface ships and aircraft increase their detectability to thousands of miles when they transmit electromagnetic energy; however, they are already detectable by radar when the radar platform can be brought within range. Submarines, on the other hand, are practically undetectable. That is, until they transmit or otherwise disclose their presence.

While the sea offers concealment to a submarine, it also penalizes. For every foot of submergence a half pound of pressure is pushing the sea water, trying to get it into all electrical leads and fittings exposed to the sea and to ground the circuits. At four hundred feet this is a two hundred pound Gremlin working on each square inch.

Think of the strains that wind storms cause to antennas ashore and afloat. While the wind velocities are much higher than the twenty knots of relative current which modern high speed submarines produce, sea water is also much denser than air, and the problems are similar. Nuclear submarines gave a new dimension to antenna problems: fatigue failure from vibration accompanying higher speeds and more frequent variation in pressures from atmospheric to deep submergence are two of them.

Submarine communications have been greatly influenced by the unusual behavior of very low frequency (below 30 KCS) radio waves. VLF has the characteristic of being able to penetrate beneath the surface of the ocean. During submerged operations in the Great Lakes on a few occasions we have learned that VLF penetrates to depths of several hundred feet in fresh water. Unfortunately, submarines rarely operate in fresh water. In salt water, this penetration is to a much lesser depth. However, submerged submarines can receive VLF at depths great enough for the submarine to remain undetected. This is why the powerful VLF transmitter, soon to be completed in Maine, is eagerly awaited. Not only will this station give a greatly increased coverage of the Arctic region, the Atlantic, and the Mediterranean for surface forces but also the station will provide increased coverage for submarines.

Called the "Silent Service," submarines on war patrol normally would observe radio silence. However, there are certain reasons for requiring our submarines to receive and transmit messages. Operating independently as they normally do, they need an additional source of information from outside the ship to assist them in locating targets. Although our target acquisition ranges have continued to increase through the years with improved sonar and radar, it may still happen that a submarine will be assigned an area where it later becomes apparent no targets are available. Thus intelligence reports from other sources are needed in order to find the more fruitful areas. On other occasions information of great value to the operational commander may be obtained and must be delivered so other submarines and allied forces may benefit from this information.

VLF radio transmissions are ground waves; the unpredictable propagation path and "skip distance" effect of high frequency sky waves do not apply to VLF. Also, VLF transmissions are less affected by ionospheric disturbances and by the auroral phenomena than HF transmissions. A loop antenna made of many turns of wire absorbs some of the energy as these VLF transmissions propagate through the water. The VLF radio signal is attenuated rapidly with increasing depth. The signal must be strong enough for the submarine radio operator to copy at depths where his ship is safe from leaving a

tell-tale wake or from being rammed by a surface ship. Our submarines can and do operate completely submerged and receive VLF transmissions without exposing themselves to detection.

How do submarines receive messages from the shore? Normally by the broadcast method, i.e., the shore station transmits at a scheduled time and on a set frequency without an answer from the ship addressee. Messages for surface ships are normally broadcast only once for there is little reason for a surface ship to miss any transmission. In contrast, a submarine may be at deep submergence during any given transmission, a fact that calls for special broadcast procedures. Messages are retransmitted by the broadcast station as many times as are deemed necessary by the submarine operational commander to insure delivery. The "recap" system of rebroadcasting all traffic at a prescribed time during hours of darkness is also used in order to aid the submarine's chance of remaining undetected.

Although the submarine receives both VLF radio waves and HF radio waves, the submarine transmits only high frequency radio waves. In order to transmit when submerged, the submarine must come to periscope depth and raise a small whip-type antenna on a mast. This antenna is quite inconspicuous at low speeds. However, at high speeds through the water it will create a wake similar to that of a periscope. Accordingly, it must be used with care. With this whip antenna the submarine operator may also copy high frequency transmissions that do not penetrate the ocean's surface. This type of broadcast will normally consist of a series of high frequencies transmitted at less power than VLF transmissions, and at frequencies that provide sky-wave reception in broad geographical areas. But while sky waves are propagated great distances, their paths are sometimes erratic.

The submarine transmits a message to a shore base by raising the whip antenna above the surface. The U. S. Navy has a ship-to-shore network of shore stations guarding a series of high frequencies available for use by all ships. An appropriate frequency is chosen and the message is delivered to a station that may be thousands of miles away. Local submarine activities ashore guard frequencies suitable for short-distance work.

In submarine-aircraft communications, the submarine must be at periscope depth, exposing either a whip antenna or a UHF antenna. UHF communications with aircraft are no mally possible at ranges less than miles; high frequency is employed f greater distances. In working wi surface ships the submarine similar must expose UHF or HF whip a tennas. UHF ranges with surfa ships are quite limited. The unde water telephone is used to commur cate with surface ships or submarin close by, say within a few thousar yards. Submarines do not normal communicate directly with each oth when submerged except when in clo enough proximity to use the unde water telephone. The usual pr cedure is to relay traffic to shore st tions for delivery via the broadcas

Let us examine the equipment wit which our submarines have commun cated. For receivers there have bee a VLF-LF receiver and a couple high frequency receivers. Tran mitters normally have consisted two high frequency equipments. On has been the old reliable 200-wa TBL or its equivalent. The other on has had a smaller power output. Hig frequency transmitters and receiver normally have covered the frequenc range of 2-20 megacycles. For shor range line of sight communications a submarine has been equipped wit a UHF (200-400 MCS) transceiver An underwater telephone is availabl for short range underwater communi cations. This underwater telephon is located at the conning station fo tactical use. The other facilities hav been crowded into a radio room o 60 to 80 square feet, with only enoug space left over for two operators.

There is a large amount of work being done in research and develop ment of new submarine communica tion equipment and systems. Ou newer submarines are being equippe with more powerful transmitters having a single sideband capability as well as the normal continuous wave (CW) and amplitude modulation (AM) capabilities. Only a few submarines are now equipped with teletype. Surface ships have used teletype for many years. However our submarines have not needed it, because there has not been a VLF radio teletype broadcast to copy. It is quite probable that in the not too distant future we will be operating VLF radio teletype broadcasts for our submarines. Much of our new equipment is compact and transistorized to take up less space in the very crowded radio spaces. We have conducted many experiments with various shapes and sizes of antennas in a search for a two-way communications capability with submarines at deep submergence.

— GOVERNMENT —

PIONEER V is the United States' newest artificial planet to orbit the sun. Launched March 8 from Cape Canaveral, Fla., the 90-pound aluminum sphere will orbit at a distance of 75,000,000 miles from the sun between earth and Venus. Pioneer V contains a 150-watt transmitter designed to permit communication up to 50,000,000 miles. Believed to be the most powerful radio transmitter ever flown into space, the radio transmitter contains solar cells that will recharge the payload's batteries every 4 hours and 55 minutes. It is believed that the solar vehicle will continue to send messages back to earth for four or five months, until it is out of the 50-million-mile range. Then, it is hoped that it will resume contact with earth in 1963, when it comes within range again.

KITT PEAK NATIONAL OBSERVATORY near Tucson, Arizona, was dedicated March 15. Maintained by the National Science Foundation, the optical observatory will be available to all qualified U. S. astronomers. The first major telescope to go into operation at Kitt Peak will be a 36-inch reflector, which will be the forerunner of an 84-inch reflector to be completed in 1961 or 1962.

NEW FCC CHAIRMAN is Frederick W. Ford, a member of the Federal Communications Commission since 1957. His predecessor, John C. Doerfer, resigned March 10.

NASA-CANADIAN GROUP will conduct a satellite study of the ionosphere in 1961. The Defense Research Telecommunications Establishment of Canada will provide the satellit and its instrumentation and will operate a network of receiving stations within Canada for recovering telemetered data. The National Aeronautics and Space Administration will provide high altitude sounding rockets and launching services to test the Canadian satellite prototype instrumentation and will conduct the launching from the Vandenberg Air Force Base (Calif.) range.

TWO TINY MICROPHONES in Explorer VI satellite are being used in a micrometeorite detection experiment sponsored by the Air Force Cambridge Research Center. The instruments measure the number of times the "paddle wheel" satellite, launched last August, is struck by dust particles in space and determine the size of the particles. A dust particle striking the satellite's surface generates an acoustical pulse which is transformed by the microphone into an electrical pulse. Then, this electrical pulse is transmitted to data accumulating stations on earth.

THE IMPACT POINT of a ballistic missile or re-entry vehicle hitting the surface of the ocean can be located by underwater detection systems developed for the U.S. Navy by Bell Telephone Laboratories and installed by the Western Electric Co. at both the Atlantic and Pacific Missile Ranges. The impact creates noise signals that are used to locate the spot where the missile hit the water. Now in operation in conjunction with the Atlantic Missile Range, these underwater detection systems are aiding recovery teams in finding and retrieving missile nose cones after their space flights.

MORE THAN 200 KEY ARMY ACTIVE RESERVE AND NATIONAL GUARD OFFICERS and civilians attended the Army Signal Corps orientation session on "Research in Space" held recently in the Pentagon. Other topics covered at the session were "Report on Combat-Surveillance" and "Trends in Officer Career Development." The annual series of orientations of the Army's Chief Signal Officer, Major General R. T. Nelson, are conducted for key officers and civilians to help them keep pace with communications and electronics in the Modern Army.

SAN BERNARDINO AIR MATERIEL AREA at Norton Air Force Base, Calif., is the first Air Force depot to begin storage and maintenance of ballistic missiles. Arrival of the first Thor in January culminated over two years' planning and eventually there will be a steady flow of Thors to the base. They will be shipped as replacements as the missiles are fired by training squadrons at Vandenberg Air Force Base and at launching sites in Great Britain. A full repair and modification capability will be phased in gradually at SBAMA. In part, this is the inspection and removal of components, check-out of sub-systems and purging and preservation of engines.

ARMY ENGINEER USES RADIO WAVES to measure the depth of polar ice caps in the Arctic and Antarctic. A modified 10-watt radio altimeter and special directional antennas for transmitting and receiving signals were used by Amory H. Waite, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, who made the first tests last September near Thule. The depth of the ice caps is determined by measuring the time required for transmitted signals to pass through the ice, reflect off the hidden ground beneath and return through the ice to the receiving antenna.

AUTOMATIC ALL-WEATHER AIRCRAFT LANDING SYSTEM which can land an airplane in any kind of weather, even when the pilot cannot see the runway, is being evaluated by the Federal Aviation Agency. Developed for the U. S. Air Force by Bell Aircraft Corp., Avionics Div., the system uses radar to track the airplane and radio to transmit control instructions to the plane's automatic pilot.

CONTRACTS: ARMY: Martin Co., continued research and development on the Pershing ballistic missile system, $82,599,690; Raytheon Co., Hawk missile test equipment, $4.5 million; Telecomputing Corp., research and development data reduction services at Holloman Air Force Base on the White Sands Missile Range, $2,084,222; General Dynamics Corp., Stromberg-Carlson Div., work on a transistorized switchboard for long distance dialing, $1,800,000. NAVY: Ryan Electronics, div. of Ryan Aeronautical Co., initial procurement of AN/APN-130 doppler radar navigation sets, spares, support equipment and engineering support items, $5,914,000; Texas Instruments Inc., production by the Apparatus div. of an advanced antisubmarine warfare (ASW) system, $4.5 million; Raytheon Co., extend range and high altitude capabilities of Sparrow III missile, $4.3 million; Defense and Industrial Group, Packard Bell Electronics Corp., production of the ASQ-17B integrated electronic central consisting of communications, navigation and identification equipment for use in high-altitude, high-speed operational military aircraft, $2,000,000; ACF Electronics Div. of ACF Industries, Inc., conversion of an electronic flight and tactics simulator, $1.1 million. AIR FORCE: Burroughs Corp., training programs for installation personnel, installation of the hardware as well as on-site logistic support and maintenance linked with supply depot support, $7,980,000; Columbia University, engineering change for study of real time data processing techniques, $2,025,199; Raytheon Co., engineering investigation of Pincushion tracking radar set AN/UPS-2.

— INDUSTRY —

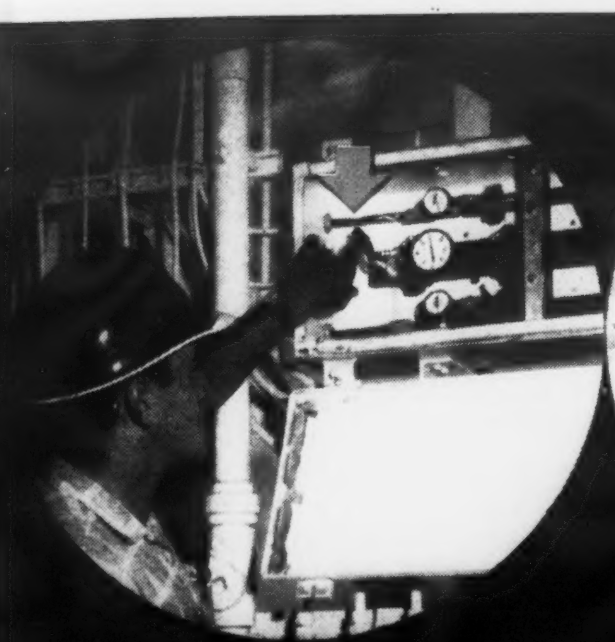
TRADENAMED "PRINTAPIX," a new Litton Industries cathode ray tube type has been developed for direct electronic printing at high speed on non-sensitized dielectric material. This versatile new electronic component is already being incorporated in facsimile, oscillography, address labeling and television type image reproduction equipment. Other applications soon will include high speed computer readout, controlled information storage and erase for military tactical display maps and stock control uses, projection transparency generation, multiple copy reproduction and simultaneous recording at any number of dispersed stations.

CONSOLIDATION OF MANUFACTURING AND SALES OPERATIONS at Kellogg Switchboard and Supply Company has been announced by George A. Strichman, president of the International Telephone and Telegraph Corporation division in Chicago. Three major product departments have been formed—central office switching, telephone and transmission, and communications systems—enabling Kellogg to streamline its management organization and to keep pace with the company's rapid growth since affiliating with the ITT System in 1952, Mr. Strichman said.

VITAL MONITOR AND CONTROL DISPLAY SYSTEM FOR PROJECT MERCURY will be designed, built and installed by Stromberg-Carlson-San Diego. Project Mercury's objectives are to put this country's first manned space capsule into orbital flight around the earth, investigate man's capabilities in the new environment and recover the capsule and the man safely. The display system will serve as the "nerve center" for the project.

NORTH ELECTRIC CO. will design and manufacture electronic switching equipment for a U. S. Air Force Air Weapons Control System, which is a ground environment complex containing major radars, data processing, communications and other special types of equipments. Under a General Electric Co. subcontract believed to exceed several million dollars, North Electric will supply mobile and fixed equipment capable of providing communications and control for a wide variety of defensive and offensive weapons to answer needs of air-space management outside the continental United States.

HOFFMAN ELECTRONICS CORP. has changed the name of its Hoffman Laboratories Div. to Military Products Div. The name change, announced by H. Leslie Hoffman, president of the parent company, was made to reflect more accurately the division's diversified activities in the military and space electronics fields. *(Continued on page 40)*



4. Here, the Styroflex* cable from the blockhouse enters the lower deck of the Titan launch Complex 16 . . .

5. Then begins to rise perpendicularly through the lower portion of the launch deck . . .

6. Climbs the side of the umbilical tower and helps send The Martin Company's Titan on a fast trip over the Atlantic Missile Test Range!

In an effort to provide greater coverage of industry activ-ties, SIGNAL is publishing the following listing of com-pany building programs, mergers and new companie

A new manufacturing plant in Los Angeles, Calif., will be built for BENDIX AVIATION CORP., Computer Div. The new building will be used to facilitate manufacture of the medium size G-15 digital computer and production of a new line of transistorized computing equipment. . . P. R. MALLORY & CO. INC. has acquired a 17-acre tract in Lexington, N. C., and will build a 60,000 sq. ft. plant for use by one of its divisions, MALLORY BATTERY CO. . . Consolidation of TRANSVAL ELECTRONICS CORP. manufacturing, research and administrative activities in a new facility in El Segundo, Calif., will make it possible for the company to undergo "a 100 percent expansion of its manufacturing capabilities," it is said. . . GENERAL ELECTRIC CO. has announced occupancy of its new Special Programs Section facility in Radnor, Pa. Established for the purpose of focusing GE's design and development capabilities on the system requirements of the U. S. Army, this section is part of GE's Defense Systems Dept. . . A new subsidiary has been formed in Geneva, Switzerland, by EITEL-McCULLOUGH, INC. The corporation known as EITEL-McCULLOUGH, S. A. will serve as a marketing function for Eimac in Europe. . . CGS LABORATORIES, INC. has formed a new Magnetic Components Div. . . . IRRADIATED INSULATIONS, INC. is a new company formed to produce insulated wire for special requirements in the electronics and missile fields. . . PAGE COMMUNICATIONS ENGINEERS, INC. has moved into new quarters in Washington, D. C. The new home office in the "Page Communications Building" more than doubles the space formerly occupied by the company. . . RAYCHEM CORP. has completed negotiations which will lead to the acquisition of BENTLEY-HARRIS MANUFACTURING CO. . . Two subsidiaries of TELEMETER MAGNETICS INC. have been merged to form INVAR ELECTRONICS CORP. . . . A new cabling division to operate at the company's North Hollywood plant has been formed by MISSILE SYSTEMS CORP. . . Stockholders of ELECTRONIC COMMUNICATIONS, INC. and W. L. MAXSON CORP. will vote soon on a recommendation of the directors of the companies that ECI and Maxson be combined. . . Formed by COLVIN LABORATORIES, INC., PRESSURE ELEMENTS, INC. is a new company which will work on the design, manufacture and marketing of pressure diaphraghms and capsules. . . The separate administrative, engineering and production departments of TASKER INSTRUMENTS CORP. will be housed in the firm's Van Nuys, Calif., facility to be completed this summer.

Frequency Spectrum

(Continued from page 24)

ment of adequate test equipment and measurement techniques which will permit the determination of the exact nature and magnitude of emitted signals at very high frequencies and above.

Measures have been, and are being, taken to bring the problem of military electronic compatibility into clearer focus. The requirements for, and methods of use of, available radio frequencies are under continuous scrutiny and study. Automation has been resorted to in the case of radio frequency records; frequency usage programs have been instigated, test procedures have been evolved for the evaluation of electronic equipments under operational environmental conditions; increased research and development efforts have been initiated with a view to improved spectrum utilization, and specifications have been developed which have as an objective the reduction of interference capabilities. Within the Navy, the Frequency Allocation Advisory Board, under the chairmanship of the Assistant Chief of Naval Operations (Communications), has, for several years, been functioning to provide information and coordinated guidance to the Office of the Chief of Naval Operations relative to the use and management of the radio frequency spectrum. Additionally, guide lines have been laid down to assist development interests in planning for new electronic devices. Procedures have been implemented to ensure that new electronic equipments will, to the maximum extent practicable, conform to national and international allocation plans. Numerous studies have been conducted on specific problem areas, and remedial measures taken. Operational procedures have been established which will permit increased sharing in the use of the radio frequency spectrum.

Further action is necessary, however, on the part of all interests if the problem of saturation of the usable frequency spectrum is to be solved. Certain of the immediate needs are as follows:

a. Provide for increased tuning flexibility so that equipments may be continuously tunable over wider ranges of operating frequencies.

b. Develop techniques which will prevent excessive frequency drift.

c. Increase efforts to reduce the emitted spectrum of transmitters to more closely approximate the bandwidth required for the transmission of intelligence.

d. Improve receiver selectivity so as to reduce image responses.

e. Engineer electronic systems rather than individual equipments.

f. Conduct tests under simulated operational environmental conditions during equipment developmental phases.

g. Develop better test equipment and measurement techniques above very high frequencies.

h. Place increased research and development effort on meeting operational requirements by means other than the use of electronic radiating devices.

Action is being taken by the military services to meet these needs. The military, however, cannot solve the frequency spectrum saturation problem alone. Complete compatibility among electronic devices cannot be brought about overnight. However, only by an acute awareness on the part of all interests who have responsibilities with regard to the development and operation of electronic devices, to the fact that the spectrum just can't take it, can we ensure that present and future electronic requirements, both civil and military, can be satisfied. Action in this regard is necessary in order to ensure that the supersonic, atomic and electronic Navy of the future will be ours.

Navy Organization for R&D

(Continued from page 17)

it would be on the subject of components. Components have been overlooked completely in the glamour of the many large systems. Admittedly, it has been easier in the past to obtain money for many large systems but the results have shown we should have paid more attention to our homework on the components. One cannot invent on schedule, as we have found to our dismay.

Reliability starts with the lowest component and the way of progress starts there also. For, if one has all the necessary components he can then put together his system in a relatively reasonable time with a strong feeling that it will turn out to be reliable.

Economy of effort dictates that each new system should constitute a significant advance over its predecessor. If this is to be accomplished economically, we must break these systems down to the smallest components on which significant experiments can be made and then do our gambling on these components. Where the payoff is large and the cost of the gamble is small, it is wise to take the chance even when the possibility of success is small, perhaps even less than one in ten. It is not economical to duplicate the development of large systems but this gambling type of research on components or new concepts in combination with new components can give us results.

If reliability is not brought in at the R&D phase of any system, it probably will never be an operational, usable one. Unfortunately, we have had too many examples in recent years of this happening.

Testing Conditions

After development and prior to procurement new equipment is sent to the Commander Operational Test and Evaluation Force for testing under service conditions. The equipment is installed in spaces identical to these in which it will ultimately operate. It will remain in this environment, be maintained by service personnel and be used under conditions for which it is designed. The length of the tests depends upon the type of equipment and may run from a few days to more than a year. It is amazing the number of equipments that fail in this actual test. This covers everything from fuzes to radars and even complete airplane systems. As modern systems are large and expensive, it is not possible to run a complete separate operational evaluation on all of them. Therefore, we bring our operational people in early on the project and they live with the system during all its growing phases and the technical evaluation. This is all done in order to get reliable and usable hardware and it is a tremendous part of our R&D effort. The Navy has found that these tests under service conditions have discovered flaws of various natures and have resulted in the saving of many dollars to the American people.

Once a product has successfully passed the evaluation and test stage and the decision has been made to procure several units, standardization and pre-production engineering takes place. The Bureaus are responsible for this phase but the Office of Naval Material also has an interest, particularly if critical materials are required. The Office of Naval Material reviews the progress of a product at this stage to insure standardization, reliability, maintainability and producibility.

The organization may seem somewhat complicated. Information, however, flows both horizontally and vertically, thus when new ideas are conceived in laboratories, all levels are rapidly informed and frequently those of promise quickly result in the promulgation of new operational requirements.

UNITED STATES SIXTH FLEET COMMUNICATES

by VICE ADMIRAL GEORGE M. ANDERSON, JR., USN
COMMANDER UNITED STATES SIXTH FLEET

Above, radioman tunes in one of flagship's teletype machines to receive fleet broadcasts while man below uses powerful binoculars to extend range of visual communications — two means of communicating among the dispersed ships of the 6th Fleet.

THE UNUSUAL IS ORDINARY for the Navy men who send and receive naval messages on board the heavy cruiser *Des Moines*, flagship of the United States Sixth Fleet—"the watch-on-deck" in the Mediterranean, the strong right arm of Allied Command Europe. Besides operating under two sets of rules, they have taken in their stride such duties as translating Turkish and Greek and connecting President Eisenhower with the White House.

Ineffective communications could make a nightmare of one of the most satisfying positions of command in the Armed Forces—my dual responsibility as Commander United States Sixth Fleet and Commander NATO Striking and Support Forces Southern Europe.

Keeping me in contact with my U. S. and NATO superiors and with the forces which make up my commands requires Sixth Fleet communications to be probably the most varied and complete of any service organization.

Built on the same framework used throughout the Navy, our communications are developed further for effective combined operations among allied nations that do not have a common language and to enhance the Fleet's ability to support the armies and air forces of our friends in Europe and the Near East.

More than 1000 messages are handled each day on board my flagship. These messages represent a major part of the "voice of command" in the Sixth Fleet—one of the world's two most powerful fleets, with its 50 ships, 25,000 men and 200 aircraft.

Knowledge of Sixth Fleet organization and of the missions assigned to it by the United States and the North Atlantic Treaty Organization is necessary to understand our communications requirements.

The Sixth Fleet is a modern, well-balanced Fleet including an attack carrier striking force, an amphibious landing force, submarine and anti-submarine elements and a variety of sustaining auxiliary ships which make it possible for the Fleet to operate indefinitely at sea without shore bases in the Mediterranean.

An instrument of national policy and power, the Sixth Fleet works for peace, stability and good will. Its aims are entirely friendly but it is always battle ready, capable of waging any kind of warfare—hot or cold, limited or general, atomic or conventional.

The 50 ships of the Fleet are organized into three main functional task forces.

First of these major task forces is the Attack Carrier Striking Force, consisting normally of two large carriers, two cruisers and about twenty destroyers. This force is the main striking arm of the Fleet. Trained, equipped and ready to fulfill any offensive, defensive or sup-

porting role of air-sea power, its hallmarks are power, versatility and mobility.

From the carriers, fly missile-equipped jet fighters and high-speed jet bombers with an all-weather striking radius in excess of 1000 miles. The cruisers and destroyers have a defensive role of protection for the carriers as well as an offensive one against potential enemy subsurface, surface and air threats.

Second is the Amphibious Force, which consists of a squadron of seven or eight combat-loaded amphibious ships with a reinforced battalion of about 2000 combat-ready embarked Marines. The force normally includes an amphibious command ship, attack transports and cargo ships, minesweepers and a variety of amphibious assault types.

With the Marines, when they hit the beach, is communications equipment to link them with their supporting aircraft and gunnery ships and with each other. During the Lebanon incident in 1958, the Sixth Fleet Marines were rapidly increased to many times the number usually present in the Mediterranean.

Third, is the Service Force. This force, forming the floating base that enables the Fleet to stay at sea for extended periods of time, is a collection of auxiliary ships including oilers, repair ships and a variety of supply and provision ships. In effect, a mobile grocery store, repair shop, hardware store and filling station, this force can keep the Fleet continuously at sea through underway replenishment; that is, through the transfer at sea of stores, provisions, fuel, ammunition and other necessities.

In addition to these three major forces, the Fleet is supported by land-based aircraft for scouting and anti-submarine operations, and by submarines, used principally to provide fleet training.

Periodically, and in time of crisis, the Fleet is augmented by a special force known as a Hunter-Killer Force. This force, consisting of a carrier with a specialized air group and accompanied by destroyers, is equipped specially to seek out and destroy enemy submarines.

The composition of the Fleet changes completely every four to six months, with ships from the United States replacing those in the Mediterranean. The only exception to the rotation policy is the heavy cruiser that has been the Sixth Fleet flagship for about two years and a few auxiliary ships in the Service Force.

The two main missions of the Sixth Fleet are:

1. Achieve and maintain at all times a high degree of readiness and combat effectiveness.

2. When in port, spread and foster good will between the Mediterranean nations and our own.

To carry out my NATO responsibilities, I have a second staff based at Naples and administered by my NATO deputy. (I am always afloat.) Both the sea-based U. S. Sixth Fleet staff and the shore-based NATO staff are about the same size, approximately 30 officers.

About half of the time of the Sixth Fleet is spent in training exercises at sea, both U. S. and NATO, as well as bilaterial or trilateral exercises with friends and allies.

The other half of the time is spent in visits to approximately 100 ports lining the million-square-mile inland ocean that the ancients called "the center of the earth."

Ships and aircraft squadrons reporting to the Fleet are expected to have developed previously those basic skills characterized by all of our U. S. naval forces. While some exercise time is allocated for maintaining these basic skills, my primary emphasis is on developing advanced task force and fleet coordination tested periodically in combined operations with our NATO allies. Such emphasis naturally requires a high level of communications efficiency.

Various Skills Exercised

Skills we continually exercise include those involved in offensive air operations, anti-air, anti-submarine warfare, underway replenishment, mine warfare and amphibious landings. Because we operate dispersed during these exercises, I seldom see in its entirety at one time what is, to me, one of the finest sights in the world—a powerful task force, spread out in formation over the blue Mediterranean, expertly executing the operation maneuvers in accordance with messages from my flagship and from my subordinate tactical commanders.

Its abilities to communicate effectively while dispersed and to operate without shore bases are two of the real strengths of the Sixth Fleet, a long-legged, free-ranging force that can shift its mobile air bases from one end of the Mediterranean to the other without asking permission from anyone.

Obviously, heavy communications traffic is common in operating and administering the Sixth Fleet. Some of the traffic burden is lessened through the major communications support given by Port Lyautey, Morocco, one of the Navy's six primary communications centers strategically located throughout the world.

Because of its NATO as well as its U. S. responsibilities, however, my communications personnel must use their two sets of operating rules with an unusually large variety of equipment. This requires that communications personnel reporting to the Fleet must be highly trained before reporting and then they must be prepared to spend additional time training on station.

The Sixth Fleet uses national-joint, NATO-combined and bilateral procedures, with radio teletype, continuous wave (CW) and voice. We use numerous forms of visual communications, too, to lighten the load on rapid transmission equipment.

English usually is used on voice circuits. It is surprising, incidentally, how well all the NATO navies and air forces use English in our international communications.

In our classified and plain language radio teletypewriter (RATT) and teletype, we normally receive English but the flagship averages two or three messages in a foreign language each day. Since we do not have a translator assigned, foreign language messages increase our handling time. Fortunately, we have such a wealth of linguistic talent aboard that we haven't been stumped yet.

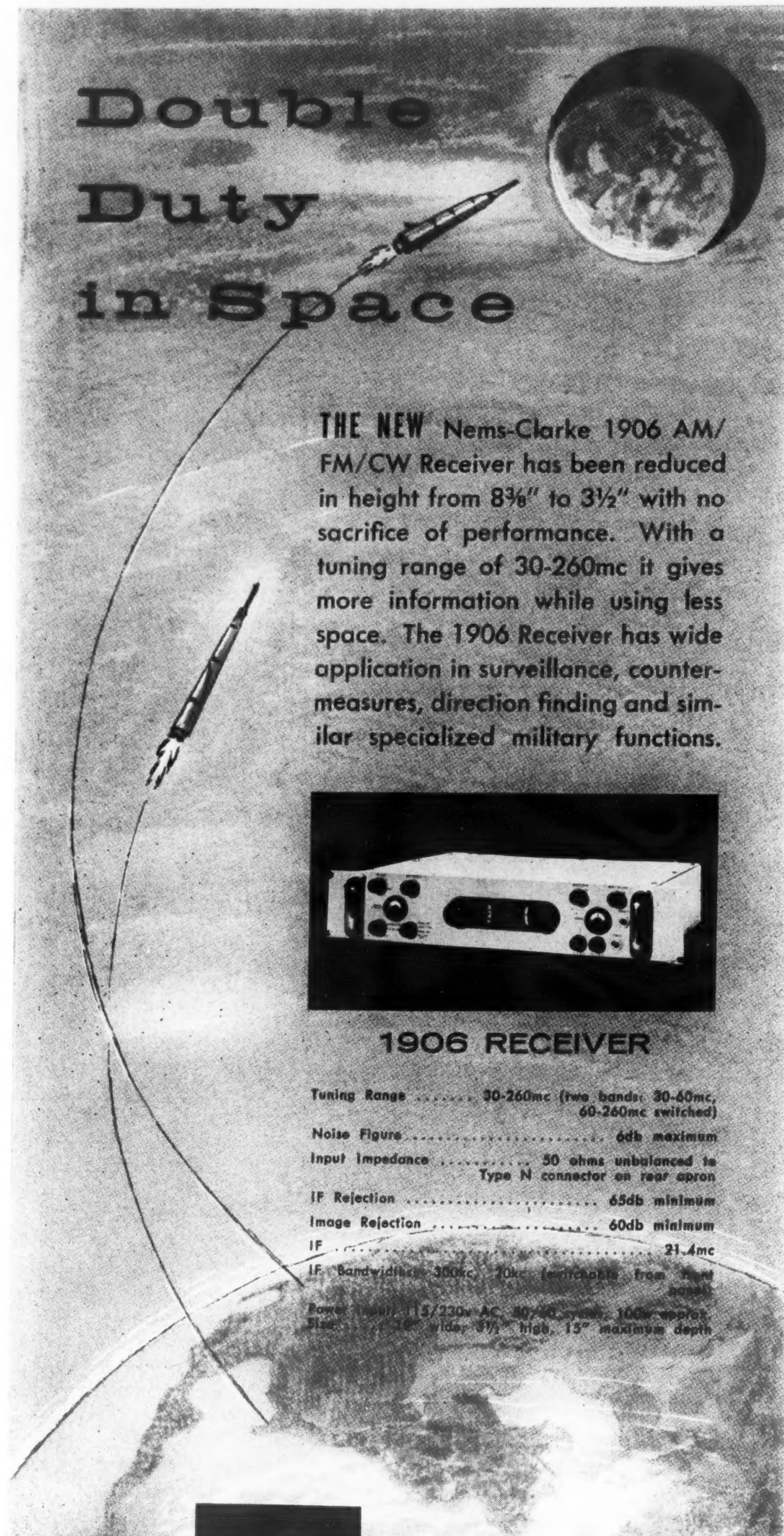
Because we usually operate dispersed, as protection against atomic attack, UHF/VHF is lost to us, except through the use of airborne relay, which permits over-the-horizon operations. Therefore, we now use low-power, high-frequency single side-band equipment for the greater part of our voice communications.

Many other changes are taking place in Sixth Fleet communications so we can keep abreast of present day speed of operations. For all necessary classified traffic, we use RATT and some multiplex equipped circuits in our major combatant ships. We have installed improved crypto equipment to work into these circuits and we have been training operators to use this equipment faster.

One of our more recent additions is the photo-facsimile equipment for obtaining area weather maps—necessities for predicting and preparing for the everchanging "moods of the Med."

Before we adopt new methods, they are evaluated closely to make sure that few, if any, changes will be re-

(*Continued on page 63*)



The Look Ahead

(*Continued from page* 11)

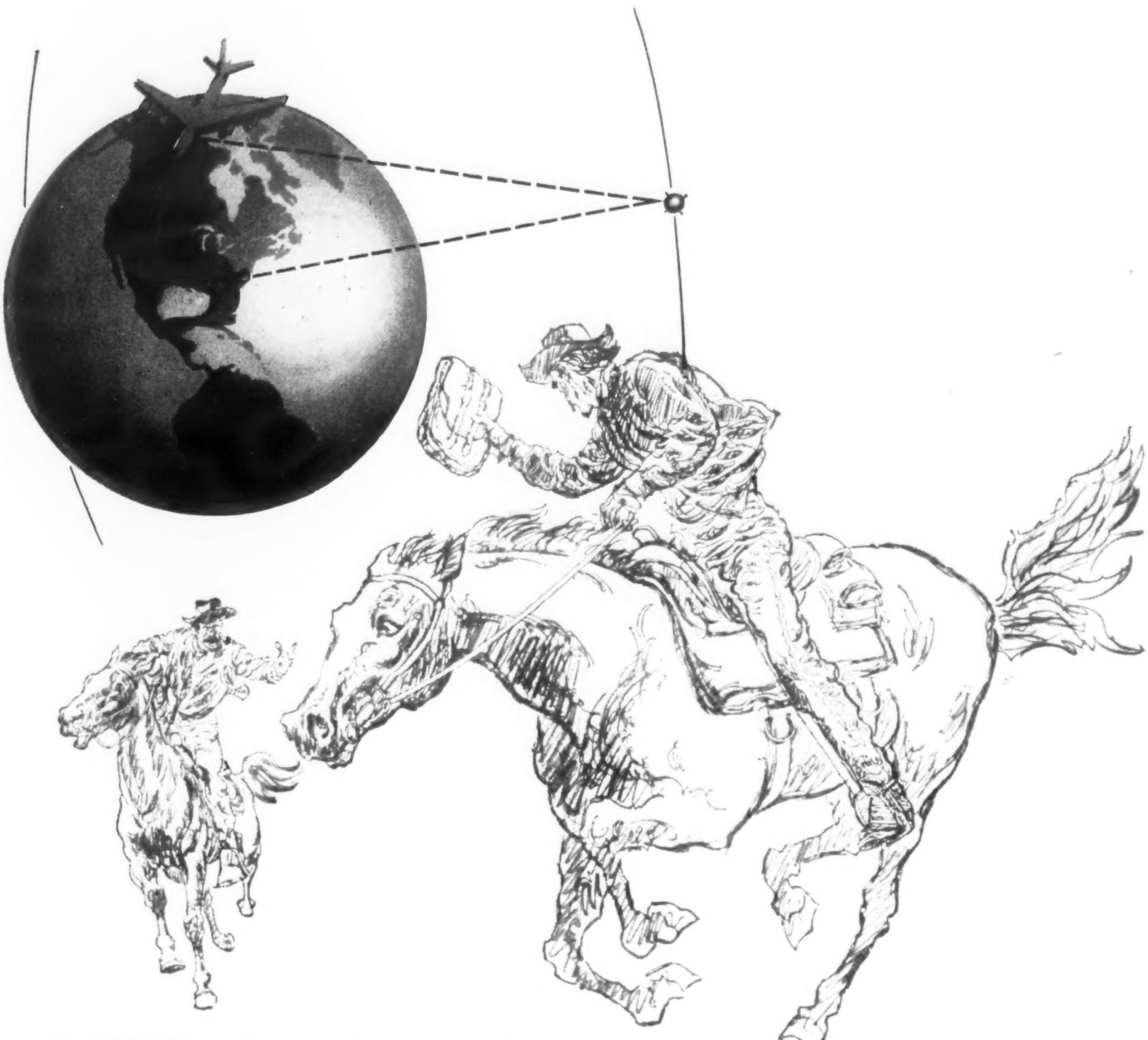
greater miniaturization in the mor complex electronic systems that fu ture designers may wish to pack int ships, missiles, or aircraft.

Hand in hand with the miniaturiza tion and simplification of component and circuitry must come the devel opment of new sources of power What good is it to launch a satellit designed to stay aloft for years if it communicating endurance is measur able in weeks? How worthwhile i it to develop a feather-weight, air borne computer if its power source i still a ponderous lead-acid battery? Solar batteries are but half an answer for they only work in sunlight. The fuel cell is promising for submarine and surface ships but not for missile and satellites. The field is wide ope for new methods of energy conver sion. The next few years may find th answer.

Conclusion

There was a time when militar laboratories had to go to some lengths to justify basic research. For instance, the Navy's early work on radar was done on "spare" time and with money borrowed from applied research projects. Not until the Naval scientists could prove they "had something" were extra funds forthcoming. Fortunately such hard-sell justification is no longer necessary. Not only the leaders in the defense establishment but those who provide the financial support have come to the realization that tomorrow's devices and weapons systems cannot be built by mere intuitive invention; there first must be a solid foundation of fundamental knowledge.

Sometimes this knowledge can best be derived from a large number of outside investigators working independently—hence the 1400 contracts currently supported by the Office of Naval Research. But outside investigators frequently lack the special orientation, and the environment for cooperative effort among many disciplines, that are frequently necessary to develop a complex military device or fully explore a new hypothesis. Also the outside investigator often does not have the expensive tools of modern research, such as a nuclear reactor or a large radio telescope. So the Naval laboratories conducting both applied and oriented basic research have become more necessary than ever before, and we can predict they will be doing more and more research of the oriented basic type in the future.



SATELLITE RELAY

. . . for modern long-range communications

Pony Express riders began an American tradition for the reliable relay of important messages over long distances. Today, Bendix is proud of its role in extending this tradition to communications through the active radio relay satellite program.

The ideal vantage point of a satellite relay permits the utilization of line-of-sight UHF and SHF techniques. Bendix is currently under contract for UHF communications equipment for satellites, aircraft, and ground stations. Work is also underway on system analysis and preliminary design to use advanced SHF techniques for high-traffic applications. The purpose of these programs is to provide reliable fixed, mobile, or range communications on a global basis.

Other space age projects at the Bendix Systems Division include magnetohydrodynamics, highly reliable radiation-resistant communication equipment, interpretation and prediction of infrared reconnaissance, new satellite stabilization techniques, and communication methods to penetrate the ionized shock layer surrounding hypersonic vehicles. Additional projects involve satellites for weather and ground infrared reconnaissance, and for radio navigation.

Opportunities are open to better engineers and scientists interested in participating in advanced space programs in an ideal scientific climate.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix AVIATION CORPORATION

Signalgram *(Continued from page 31)*

DATATROL CORP. is a newly organized firm of computer programmers and data processing consultants. Located in Silver Spring, Md., the company will offer services such as planning, defining, analyzing and evaluating processing systems; selecting equipment; training personnel and developing techniques.

—GENERAL—

87TH CONVENTION OF THE SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS will survey the new principles presently being introduced in the motion picture and television industries. Scheduled for May 1-7 at the Ambassador Hotel in Los Angeles, the convention will include the presentation of a progress report on video tape standardization and a special session on training personnel for television and motion pictures.

NEW FLUID AMPLIFIER able to perform many of the control operations needed for millions of fluid-actuated systems was described by Army officials recently. A greatly simplified control device, the amplifier uses gas or liquids instead of electric currents to operate machines. The device was unveiled at the Army's Diamond Ordnance Fuze Laboratories, Washington, D. C., where its three civilian inventors are employed

SMALLER COMPUTER CONTROL SYSTEMS designed to achieve one special purpose will be used on a large scale by companies in the next three years. This prediction was made by Chalmer E. Jones, vice president, Control Systems Div., Daystrom Inc., who addressed the Instrument-Automation Conference in Houston, Texas, February 1. In many instances, large universal computers will give way to these one-purpose computers which cost $30,000 to $40,000, or one-tenth the amount of the large universal computers, according to Mr. Jones.

MARKETING PROBLEMS faced by medium-sized companies who sell to the Government have been increased by Congress' action in directing Government agencies to procure an increasing percentage of specialized equipment through the advertised invitation for bid. This opinion was expressed by Norman I. Schafler, president, Consolidated Diesel Electric Corp., at the recent National Space/Missile Conference in Washington, D. C. He stated, "Medium-sized specialized companies who have made permanent contributions to the military supply system are caught in a squeeze. The costs of maintaining research and development staffs and of providing spare parts logistics and field service organizations place them under a very definite handicap when they have to compete on a purely price basis with manufacturers who are simply looking for business to cover current overhead and who have no intention of becoming a permanent supplier or of contributing technical advances to the state of the art."

SURVEY ON ENGINEERING WRITING to find what management is doing to help technical people communicate better is being conducted by the Technical Writing Improvement Society. Underlying the survey is the desire to find why industry is not doing more to help their key professionals, particularly engineers, write better. Questionnaires are being sent to more than 1,000 of the country's top firms in all industries. Results of the survey will be published by TWIS this June.

CALENDAR OF EVENTS

APRIL 11-13: Spring Assembly Meeting of the Radio Technical Commission for Marine Services, Willard Hotel, Washington, D. C.

APRIL 11-14: Eighth Weather Radar Conference, sponsored by the Northern California Branch of the American Meteorological Society in cooperation with Stanford Research Institute, Sheraton-Palace Hotel, San Francisco.

APRIL 19-21: Symposium on Active Networks and Feedback Systems, cosponsored by the Institute of Radio Engineers and U. S. Defense Research Agencies in cooperation with Polytechnic Institute of Brooklyn, Engineering Societies Building, New York City.

APRIL 21-22: Seventh Annual Convention of the Society of Technical Writers and Editors meeting jointly with the Technical Publishing Society, Drake Hotel, Chicago.

May 9-12: Summer Instrument-Automation Conference & Exhibit of the Instrument Society of America, Civic Auditorium, San Francisco.

MAY 18-19-21: Fourth Annual Industrial Mutual Aid & Disaster Control Conference, sponsored by the National Institute for Disaster Mobilization, Inc., Netherland-Hilton Hotel, Cincinnati, Ohio.

MAY 24-26: Fourteenth Annual Convention of the Armed Forces Communications and Electronics Association, panel presentations and exhibits, Sheraton-Park Hotel, Washington, D. C. DON'T MISS IT.

MARINE CORPS

communications—electronics

by BRIGADIER GENERAL HARVEY C. TSCHIRGI, USMC
Assistant Chief of Staff, G-4,
Headquarters, Marine Corps

THE MARINE CORPS is dedicated, by tradition and by law, to the art of amphibious warfare. There is but one principal mission for Marine Corps communications-electronics — to support amphibious operations by providing a specifically tailored command and control system.

Constituted specifically for the prosecution of military operations at the juncture of the land and the sea, combat units of the Marine Corps are balanced, integrated air and ground elements capable of quickly generating military power, measured as needed. The Marine Corps is the nation's amphibious "force-in-readiness," ready to go any place at any time. This overriding military duty as a force-in-readiness also pervades every facet of Marine Corps communications-electronics.

Air-ground Fleet Marine Forces are light, streamlined and adapted to living in ships and fighting from them. Organizational flexibility permits the formation of large landing forces or small forces. Each landing force requires its own communications-electronics system. Through organizational structuring, each landing force commander is provided, and controls, his own communications-electronics system.

Modern Amphibious Doctrine

A landing force, whether large or small, is a compact entity in which all personnel work, train and live as a unit. The Fleet Marine Forces exploit the flexibility, mobility and operational economy of the Fleet. These Marine combat units are prepared to project naval power to an area of actual or potential crisis at precisely the right time and in the degree of strength needed to counter or discourage enemy ventures. In many cases, the early or potential commitment of Marine units has prevented hostile actions from developing into major conflicts.

The modern doctrine of an amphibious operation features the helicopter transportability of assault elements, separation of units and dispersion of personnel, exploitation of carrier or land based aircraft and naval ships for fire support of ground troops, and a communications-electronics command and control system. The doctrine has equal validity in nuclear and non-nuclear warfare.

The amphibious assault is the most complex form of combat. It requires an organization composed of small, balanced units which can deliver a tremendous amount of precise shock power. These units must operate over a large area, especially in nuclear warfare. In a non-nuclear situation, there may be less dispersion in keeping with the more modest dimensions of conventional firepower. But even here, the mobility and flexibility of the helicopter, coupled with the versatility and reliability of air and naval fire support, enable the landing force to seize and control areas of unprecedented size. Figure 1 shows an artist's conception of Marine Corps assault helicopter, HR2S, in action.

To survive on the beach, each commander must have immediately available a communications-electronics capability to control and coordinate not only his own units, but if need be, the support available from other units afloat, ashore, and in the air. Through his communications-electronics system, the commander must receive and disseminate adequate and

Figure 1.

PH

timely information; maintain effective surveillance; process information in making his decisions; transmit orders to rapidly maneuver small, mobile, semi-independent fighting units to close combat with an enemy; apply his firepower rapidly and with precision under all conditions of weather, visibility, terrain and enemy action; and control ample and timely logistical support.

Such a concept of operation places tremendous pressure on all elements of military technology to develop necessary equipment. The pressure is particularly keen in the communications-electronics field. Inadequate communications-electronics can very well be disastrous to military operations. To assure such a capability, communications - electronics matters are integrated with the entire weapons system research and development process of the Marine Corps. The Marine Corps frequently relies on the other Military Services to develop equipment which can be adapted to amphibious operations.

The Commandant of the Marine Corps is charged with responsibility for developing, in coordination with the other three Military Services, tactics, techniques, and equipment for land forces in amphibious operations. The Commandant has directed that many aspects of this program be developed by the Marine Corps Schools at Quantico, Virginia. Marine Corps Schools combine much of the developmental and educational effort of the Marine Corps.

Under the supervision of the Commandant, communications-electronics requirements are determined in the Marine Corps Landing Force Development Center at Quantico. The Center serves as the principal field agency for the development of landing force organization, concepts, doctrine, tactics, techniques, equipment, and for service testing of equipment. Here, integrated communications-electronics requirements are tailored as a part of total weapons systems.

If equipment presently on hand will not suffice for future weapons systems, new equipment programs are planned. New programs are based on projected state-of-the-art studies by research and scientific activities of the Department of Defense and private industry. Each new equipment program, although related to a total weapons system, must be evaluated and integrated into a master communications-electronics plan. Whenever possible, equipment to be used solely by the Marine Corps is avoided. Equipment and developmental programs of the other Military Services and private industry are surveyed for possible adaption or application to Marine Corps requirements. Only as a last resort is a new equipment program submitted to the Commandant for approval.

When approved, the Commandant informs the Army, Navy, and Air Force of the Marine Corps program. The other Military Services also keep the Marine Corps informed of their new equipment needs. Quite often new equipment is developed as a joint effort. Should the Marine Corps be designated as the initiating Military Service for ground communications-electronics equipment, the Quartermaster General of the Marine Corps can develop the equipment or the characteristics of the equipment can be turned over to the Bureau of Ships, Department of the Navy, for development. In the case of airborne communications - electronics equipment, requirements are submitted to the Chief of Naval Operations for incorporation into the program of the Bureau of Weapons, Department of the Navy.

As the weapons system moves toward implementation, several concurrent actions evolve. Models of equipment are produced and then service-tested by the Marine Corps Landing Force Development Center or one of the other Military Services before it is approved for use in the Fleet Marine Forces. After approval of the system by the Commandant, doctrinal publications are prepared for use when the new tactics, techniques, and equipment are introduced. The Chief of Naval Operations is requested to modify amphibious ships and aircraft to support the new concept. At an appropriate time the Marine Corps Educational Center, also at Quantico, Virginia, includes the new concept in its curriculum. Thus development is wedded to education and training.

The Education Center has the mission of training officers in the tactics and techniques of warfare with emphasis on amphibious operations. Included in its organization is a Communication Officers School. However, all schools include communications and electronics as a very important part of command and staff training since success in battle is so dependent upon the commander's use of his communications-electronics system.

Equipment Requirements

Amphibious doctrine demands that Marine commanders have communications-electronics equipment which is reliable, light, highly mobile or portable, powerful, multichannel, rugged, waterproof, simple to operate and maintain, and logistically easy to support.

The fluid nature of amphibious operations requires an alert and flexible system of communications with firm centralized control, which nevertheless permits precise decentralized execution. Mobility, speed of execution and dispersed positioning have overtaken the feasibility of wire communications in all but rear areas and within command posts. Radio and radio relay are now the primary means of communications. This reliance upon radio is aggravated by increased distance which World War II and Korean War equipment cannot achieve. Lack of proper frequencies has forced the introduction of multichannel communication equipment.

A great phenomenon of amphibious warfare has been the increased need for electronics control, guidance, detection and warning devices within assault elements. In order for the commander to make a sound decision, he must eliminate the "unknowns" and obtain as much information as possible about the enemy. The advent of dispersed military units, armed with mass destruction weapons and capable of rapid movement, has given strong emphasis to the use of camouflage, concealment, and deception. The enemy seeks to hide his exact location, size, disposition, and intentions. The battlefield, replete though it be with powerful weapons, could, in fact, look empty.

Past battles did not present this problem since opposing forces were in almost daily contact. Dispersed warfare, by its very nature, creates many unknowns. With large void areas between units the relationship between friendly and enemy positions is not so readily discernible, and the enemy is capable of approaching from any direction on the ground or in the air. Electronics information collection and detection devices are required which afford all-round coverage against an enemy who cannot be seen by the human eye, especially during periods of fog, haze, and darkness.

The advent of missiles for fire support and for anti-aircraft protection has introduced a complete weapons system requirement for guidance and detection radars, as well as high speed fire control computers.

Air units of the Fleet Marine Forces require a family of electronics devices for early warning, aircraft intercept control, all weather close air support control, and aircraft landing control.

With the increasing complexity and tempo of warfare, the Military Services are investigating equipment using data techniques as electronics aids in collecting information, improving speed, accuracy, and quantity of the information needed by a commander before he can make a timely decision. Already extensively used in business administration, the Marine Corps is evaluating the application of data techniques to tactical needs.

Great strides can be made in engineering communications - electronics equipment to military necessities. For instance, personnel and training time must be saved by equipment which is easy to operate, and simple to support and repair. Financial economy and the fact that extensive repair under combat conditions is so difficult are also extremely important considerations.

The Marine Corps therefore has a requirement for a single family of communications equipment in which all models operate on the simplest of controls. Latest engineering state-of-the-art techniques must be incorporated to provide greater equipment capability and efficiency—e.g., transistors for lighter packages. Solid state devices and high quality components are needed to increase reliability and reduce maintenance. Modular techniques must be used to make repairs easier and reduce the number of highly skilled technicians required for combat maintenance. The need to reduce expenditures and simplify logistics requires interchangeable parts and components throughout the entire family of equipment. Design must also permit use of the same basic test and repair equipment throughout.

Equipment Program

Naval facilities for strategic or long-haul communications are the responsibility of the Chief of Naval Operations. The Marine Corps is thus free to concentrate on tactical communications - electronics equipment to be used in the battle area.

At present, an integrated equipment program is well underway to meet operational needs. In the communication field, most of the new equipment is being designed to single sideband techniques thereby capitalizing on low power, but increased range capabilities. Tactical communication requirements are being met by development of several sets. Although each item of equipment is designed to meet specific operational needs, collectively they have all been combined into a complete family of equipment. The tactical family of radio equipment is as follows:

1. A small light weight single sideband transceiver within the smallest tactical units for close combat. Intended for use by platoon and company commanders, this transceiver will be used to control fire support and small dispersed maneuvering elements in the company zone of action.

2. Completely compatible with the smaller set, a manpacked transceiver for reliable communications over the entire battalion tactical area of responsibility. This transceiver will have two other features, each of which will increase its transmission range. It can be operated on the ground with a more elaborate antenna system or mounted in a vehicle with a higher powered amplifier. Such a transceiver will assure the battalion commander control of his ground combat elements. Another set, similarly configured, will be used by Marine pilots on the ground for positive frontline control of close support aircraft. Since support by Marine aircraft is brought in extremely close, each mission requires detailed integration with the fire and movement of ground and naval units, and positive control by a pilot on the frontlines. This set will do that job. Figure 2 shows Single Sideband Radio Set AN/MRC-83.

3. A mobile high-powered radio set which will be used for longer haul tactical and administrative links at battalion/squadron, regiment/group, and division/wing levels. This set will be backed up with a compatible team-packed radio that can be displaced to remote locations to take advantage of more favorable siting unaccessible to the mobile equipment. The basic mobile radio will also be mounted in a helicopter transportable shelter and combined with ancillary equipment for use on circuits requiring large volumes of traffic. This latter equipment will be capable of the many modes of operation required at the higher echelons. It will also be used to tie the senior Fleet Marine Force Headquarters to any worldwide communication system.

The communication requirement to replace wire between widely dispersed headquarters of the helicopter-borne assault force has been met by a recently introduced team-packed radio relay set. Basically designed for multichannel voice traffic, the set is also capable of simultaneous teletypewriter operations. This basic radio relay set also is configured in several mobile mounts which are helicopter transportable. Figure 3 shows Multichannel Radio Relay Set AN/TRC-27.

In the electronics field, two typical equipment items are of particular interest. Already authorized in the Fleet Marine Forces is an electronics device for tracking mortar and artillery projectiles in flight and, in so doing, locating the position of the enemy source. The second item, soon

(*Continued on page 55*)

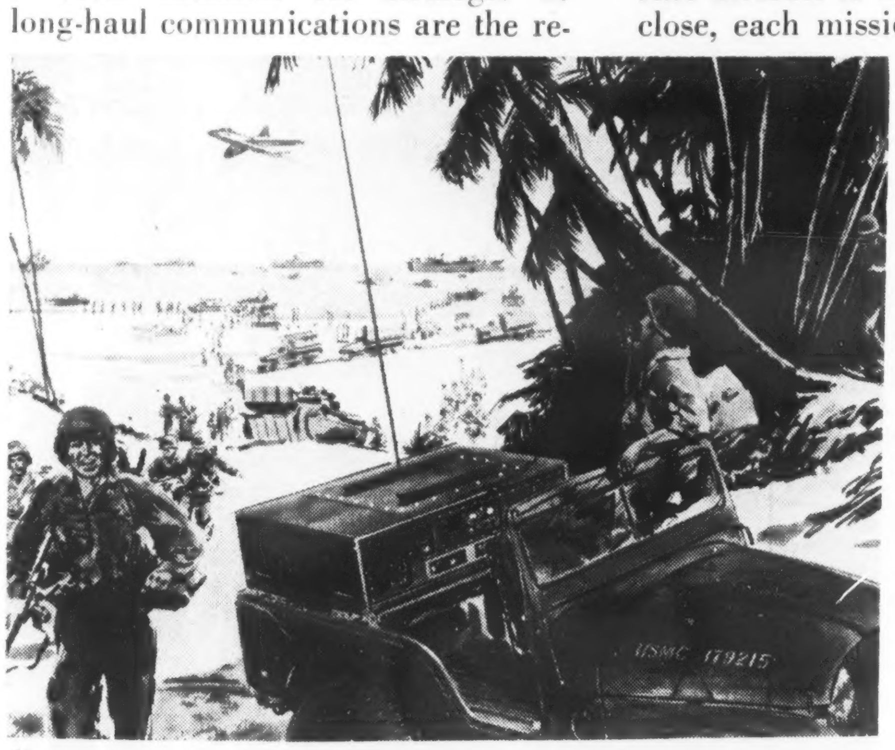


Figure 2.

Figure 3.

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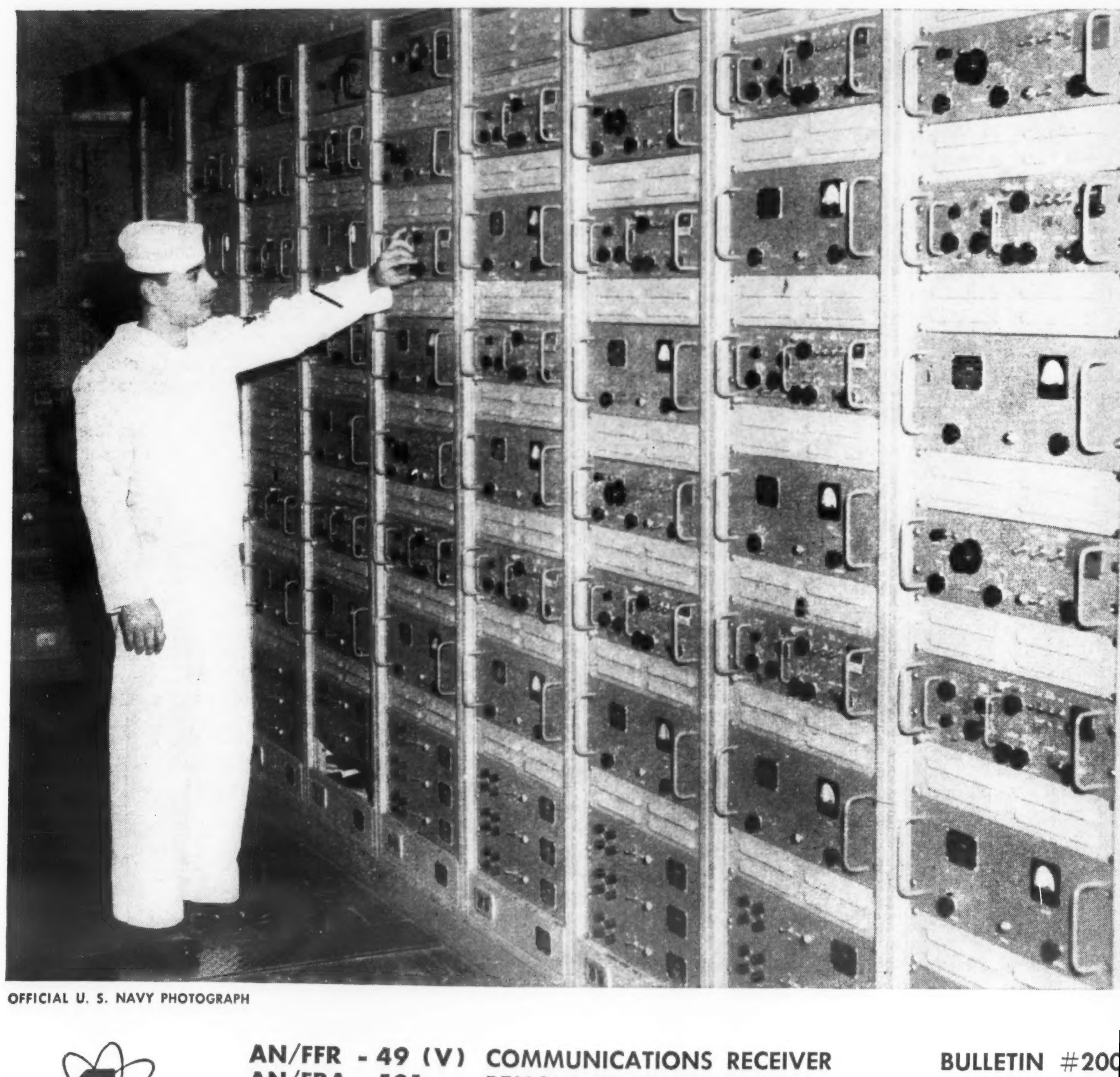
BROADCAST

TMC is proud of the part it has played in the modernization of the U.S. Nav Communication program.

Illustrated are the AN/FRA 501 Remote Control equipment being used with th AN/FRR 49 (V) Receiver.

On the right is a typical installation of the AN/FRT 39 - 10 KW Radio Trans mitter used for voice and 16 channel telegraph transmission on an SSB and ISB basis

TMC will shortly fit these transmitters with the AN/URA-30 Frequency Synthesize providing stabilization of 1 part in 10[8] per day.



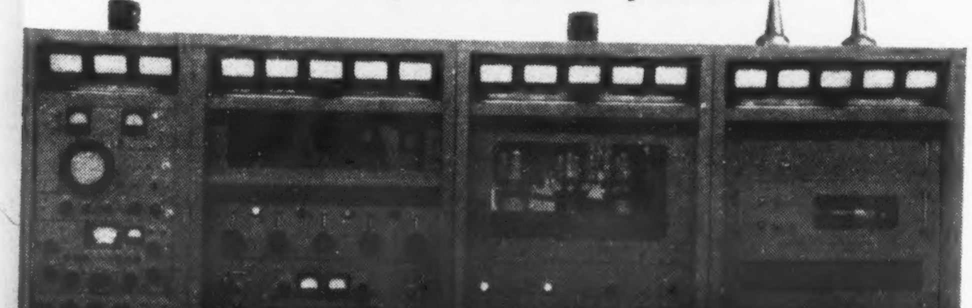
OFFICIAL U. S. NAVY PHOTOGRAPH

AN/FFR - 49 (V)	COMMUNICATIONS RECEIVER	BULLETIN	#20
AN/FRA - 501	REMOTE CONTROL SYSTEM	BULLETIN	#124
AN/FRT - 39A	10 KW TRANSMITTER (opposite page)	BULLETIN	#207
AN/FRT - 40	40 KW TRANSMITTER (opposite page)	BULLETIN	#206

• THE TECHNICAL MATERIEL CORPORATION •

OFFICIAL U. S. NAVY PHOTOGRAPH

Below is the new AN/FRT 40-40 KW Radio Transmitter to be installed where services require such power.



THE TECHNICAL MATERIEL CORPORATION • MAMARONECK, NEW YORK.

by

C. A. BASS,
L. H. FEHER,
W. E. LEAVITT
and M. L. MUSSELMAN
RADIO DIVISION, U. S. NAVAL RESEARCH LABORATORY

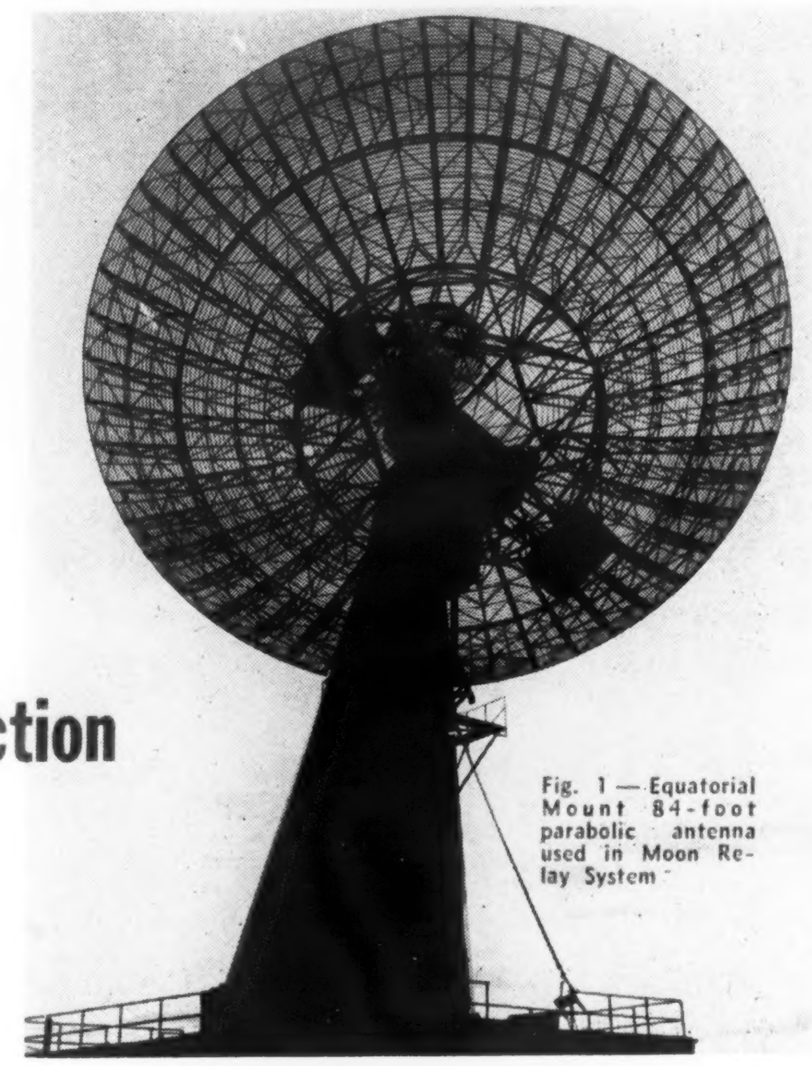


Fig. 1 — Equatorial Mount 84-foot parabolic antenna used in Moon Relay System

COMMUNICATION by moon reflection

NAVAL RADIO COMMUNICATIONS capability is being increased dramatically by the addition of circuits employing signals reflected from earth's natural satellite, the moon. Early in the past decade, scientists of the Naval Research Laboratory demonstrated that most of the signal energy bounced back by the moon to the earth in a frequency band near 200 megacycles originated from a small central area on the moon's surface. This information immediately suggested that this mode of wave propagation would provide signal coherence in a band wide enough for radio communications. The results of further investigations since that time have shown the practicability of establishing a useful earth-moon-earth radio communication circuit. Experimental moon-reflection teletype circuits from the East to West Coasts and Hawaii were first demonstrated by U. S. Naval Research Laboratory in 1955 and 1956.

Optimum Frequency Range

For such a circuit, the optimum operating frequency falls within the 100 to 10,000 megacycle part of the radio frequency spectrum. Below 100 megacycles, the earth's ionosphere limits free passage of the waves, and above 10,000 megacycles, serious absorption effects occur in the atmosphere. Within the 100 to 10,000 megacycle band, many controlling factors must be considered, including normal circuit attenuation, fading, polarization (Faraday) rotation, sky temperature variation, doppler shift, and antenna pointing and tracking problems.

Mechanics of Reflection

The mechanics of radio wave reflection from the moon is complex. It appears that the moon can be treated as a semi-smooth reflector with characteristics similar to those of a fairly level desert area. Studies of the fine structure of the return from individual sharp pulse transmissions indicate that reflection actually occurs simultaneously from several small well-defined areas spaced close to the center of the moon's surface as seen from the earth. Negligible interference is produced by other areas out to the moon's edge. The received signal is thus a highlight type of return. It takes $2\frac{1}{2}$ seconds for a terrestrial radio signal to make the round trip to the moon.

Libration of the moon causes change of aspect of the areas reflecting energy and also variation in the number of areas contributing. If it is kept in mind that the lengths of the radio waves involved would be at most several feet and that the reflecting areas are many miles apart, it can be envisioned how small changes in the moon's position with respect to any given point on earth could produce marked phase change of each individual reflected ray. This effect results in a fading characteristic for the moon circuit very much like that commonly known as "multipath" in terrestrial circuits. A study of moon signal fading for a group of frequencies only a few hundred cycles apart shows that no consistent correlation exists. In addition, since the earth is within the Fresnel zone of the moon when considered as a reflecting antenna, amplitude variations may be expected from this cause. As with terrestrial circuits, frequency diversity can be employed in the moon circuit to help overcome the effects of fading.

Circuit Attenuation

The change of attenuation of the earth-moon-earth circuit with frequency has been confirmed experimentally. It appears to be typical of free space attenuation for a target of almost constant radar cross section, which means an increase between isotropic antennas of about 6 decibels per octave of frequency. The actual measurements were made with parabolic antennas of fixed size. The increase in antenna gain with frequency, considering that two such antennas are used in each circuit, more than compensates this loss, so that there will be a net gain of 6 decibels per octave. For example, in comparing 400 with 2000 megacycles for any given size of antenna and emission power, the higher frequency will provide about 14 decibels advantage in signal-to-noise ratio, neglecting the effect of sky temperature difference.

The plane of polarization of a radio wave passing through the ionosphere in the presence of the earth's magnetic field changes angle, an effect

which is an example of Faraday rotation. The degree of rotation for a given set of conditions is dependent on frequency, decreasing with higher frequency. This rotation effect varies along the propagation path and can cause long term fading when antennas with only one polarization are used, particularly in the region of 100 to 500 megacycles. This effect is negligible above 1000 megacycles. Rather than attempt to compensate Faraday rotation by adjustment of linear polarized antennas, it is preferable that circular polarized antennas be used for transmitting and receiving. This also automatically compensates for any variation of wave polarization resulting from relative position of the moon at widely spaced sites on earth and for the type of antenna mounts employed. When more than two stations are involved, the sense of the circular polarization must be changed at some stations if all are to communicate, if the same antenna is used for both transmission and reception.

Since the moon reflection circuit utilizes highly directional antennas which are normally pointed well above the horizon most of the time, it should be possible to eliminate much of the terrestrial noise background by employing suitable antenna design and equipment filtering. An extremely sensitive receiving system can then be used to full capability since the sky temperature is fairly low, particularly above 1000 megacycles. For example, the effective noise figure of a receiving system over-all can be as low as ½ decibel if the sky temperature is 40 degrees Kelvin, while the noise figure of the receiver measured by standard methods is 3 decibels. Temporary degradation of over-all noise figure will occur when the sun or other noise sources appear in the receiving antenna's beam. Aside from this type of deterioration, which is predictable, the circuit will inherently be reliable so far as noise variation is concerned.

Doppler Shift

The doppler effect apparent as received signal frequency shift is caused by the relative earth-moon motion and the earth's rotation about its axis. It must be included as an operational factor. The extent of doppler shift increases as the signal carrier frequency increases and is to some extent determined by the physical location of transmitting and receiving sites on the earth. Except near the polar areas, the greatest contribution to doppler shift is made by the earth's rotation. Maximum frequency displacement occurs when the moon is near the horizon and is zero when the moon is at or near zenith. Since doppler effect is dependent on site location, all stations must have advance information on an individual basis so that they can program doppler tracking in the receiving equipment. Transmitted carrier frequency must be very exact if doppler shift is to be predictable with sufficient accuracy for operational systems.

Tracking the moon (pointing the radio antennas) is basically not too difficult a problem, mainly because the future position of the moon is known and published to an accuracy greater than necessary for radio tracking (e.g., *Improved Lunar Ephemeris*, published yearly by the Nautical Almanac Office, U. S. Naval Observatory, Washington 25, D. C.). Even for the large antennas used at the higher frequencies in which the angle subtended by the beam is a fraction of a degree, tracking appears entirely practical. The moon subtends an angle of ½ degree as viewed from the earth. Consequently, the beamwidth of the antenna should not much exceed this angle and the accuracy of pointing must be in the order of $\pm 1/10$ degree so that the antenna beam is kept closely centered on the moon.

An equatorial mount is suitable for the antenna at the lower frequencies where the beamwidth is sufficiently large to permit simple correction for declination and local hour angle. This type of mount is relatively simple but is largely restricted to tracking the natural celestial bodies. The elevation-azimuth type of mount is more universal in its application but requires complex computations using ephemeris data to derive the tracking coordinates. A rather complex computer can be justified for this purpose since it can serve for other functions, such as computing doppler. For the elevation-azimuth mount, high tracking rate capability is needed to follow the moon through zenith; however, presently available equipment is able to track to within a fraction of the antenna beamwidth even at zenith.

For two sites to establish communications via the moon, it is essential that both be able to "see" the moon at the same time. It is also possible to use intermediate relay stations that can store a message and forward it at the proper time. The available time in a 24 hour period that the moon is simultaneously visible at any two points can vary from zero to 24 hours in the polar regions, from zero to 15 hours in the latitude of Washington, D. C., and from zero to 12 hours for the equator. Not only the length of time but also the time of day is variable during the lunar cycle, but the exact time for communications can be predicted and can therefore be scheduled in advance.

Applications

Design of a point to point moon communication system must take into account the many factors discussed as well as the state of the art as regards equipment. Because the path loss is large, as is also true in terrestrial scatter circuits, the system must use the highest gain antennas, highest powered transmitters and most sensitive receivers presently available within practical limits of size and cost. The fading characteristic of the moon circuit will no doubt lead to the development of new techniques which will facilitate fullest use of the circuit.

The Navy has begun application of this mode of communication with an ultra-high-frequency two-way circuit between Washington and Hawaii. Operation of this circuit will result in experience that can be applied to the further development of satellite communication systems. The Washington-Hawaii circuit employs 84-foot equatorially mounted parabolic antennas at both the transmitting and receiving sites (Fig. 1). Circular polarization is used, doppler shift is compensated manually, and tracking is semiautomatic. The transmitters are rated at 100 kilowatts and are operated in frequency diversity. The system has already demonstrated its possibilities for teletype and facsimile transmission.

Communication via moon reflection offers message transmission capability between distant points with a certainty as regards the propagation path which is unique. The major deficiency of such a system is that the time available for communication is both limited and variable. However, it must be remembered that no other system or mode of radio communication can be considered completely available so far as its propagation aspects are concerned, with possible exception in the case of circuits using very low frequencies. It can be expected that the moon circuit will assume a place in military communications as a valuable addition to the previously available facilities. One of its most useful roles can be direct transmission of long haul low priority traffic that can be delayed until the moon is available, thus making other circuits more available.

DESIGN CONSIDERATIONS IN THE DEVELOPMENT OF NAVAL COMMUNICATIONS EQUIPMENT

Fig. 1—Type RBC General Purpose Communications Receiver

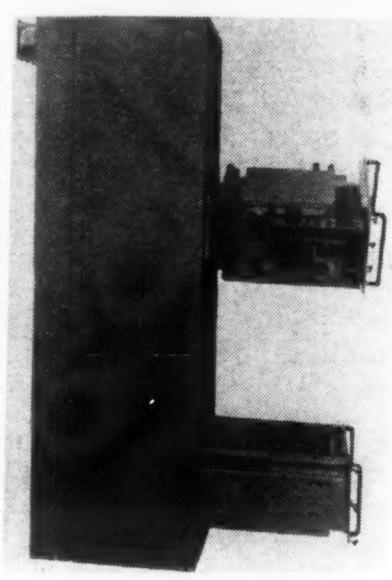


Fig. 2—AN/WRT-2 High Frequency Transmitter

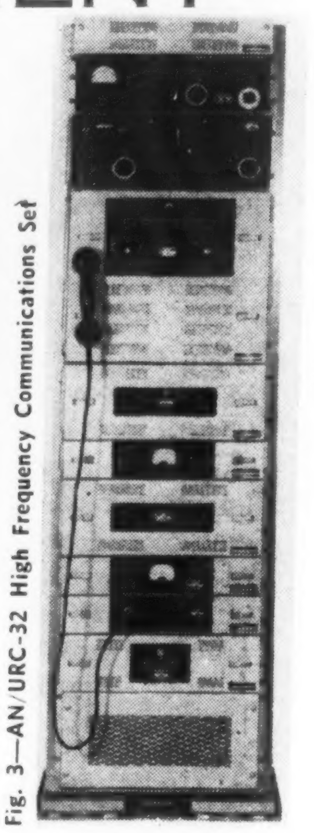


Fig. 3—AN/URC-32 High Frequency Communications Set

by
REAR ADMIRAL R. K. JAMES, USN
Chief, Bureau of Ships

FROM THE RESEARCH LABORATORIES of the government, the universities and industry come reports on new materials, new techniques and new theories. The technical divisions of the Bureau of Ships study these reports and translate the basic data into development projects related to their specific field of interest. These projects, to get financial support, must show promise of meeting specific operational requirements set forth by the Chief of Naval Operations. Moreover, the cost of pursuing the project must be commensurate with the gains anticipated.

When the feasibility of a developmental project has been demonstrated in the laboratory, it then becomes an engineering project subject to certain stringent requirements embodied in a performance specification. Contrary to popular opinion, these specifications are not maliciously contrived, but merely reflect the awareness of our technical people of the functions to be performed, the conditions that may be expected, the state of the art and the ingenuity of American industry.

The Bureau of Ships is currently attempting to simplify specification requirements by altering the format and text and by more accurately defining the intent of equipment and general specifications. Greater emphasis will be placed on industrial standards. Less emphasis will be placed on the format of instruction books and on the style of drawings and the choice of materials. The practice of referencing great numbers of specifications, each of which in turn references others, will be sharply reduced. The ultimate goal is a self-sufficient specification. There is but one purpose for this program—to reduce the cost of the equipment which will fulfill its functions under any conditions which the ship can survive.

Each new system or equipment is subject to exhaustive laboratory and operational testing before the design is released for production. In the future, much of the testing now being done in the laboratories under the Bureau's management will be done in the manufacturer's plant or in commercial laboratories, subject to verification by subsequent government inspection or test. Future contracts will indicate this change.

All of the above discussion is general in nature and is applicable to all types of electronic and other equipment under the cognizance of the Bureau of Ships. That which follows applies more specifically to general purpose communications equipment for shipboard use. Administrative

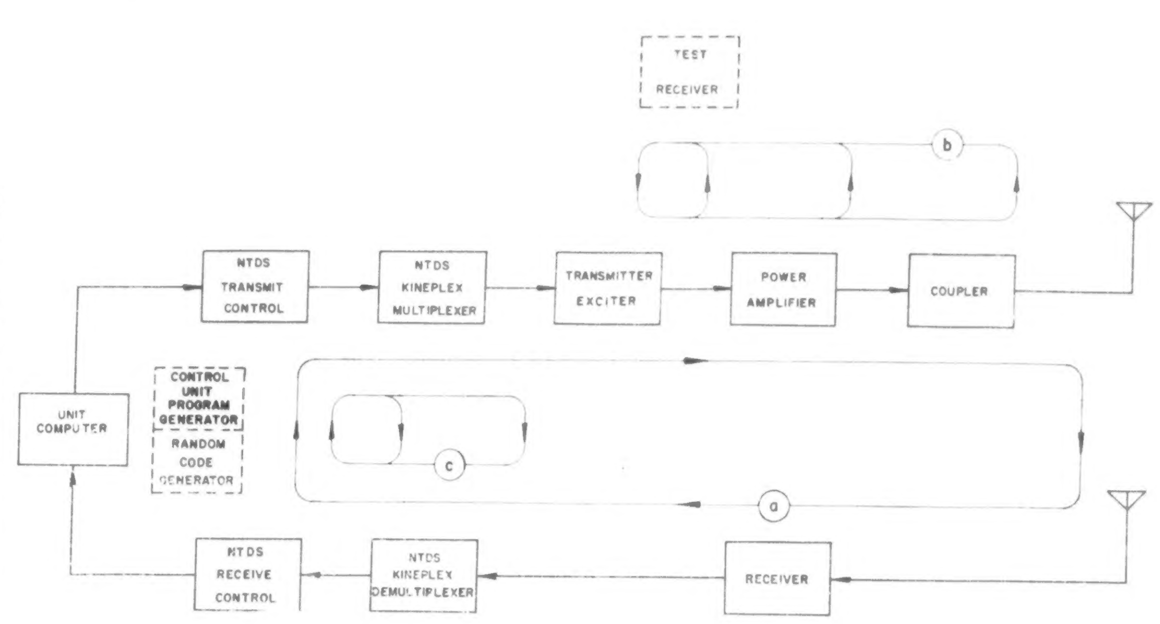


Fig. 4—Block Diagram of Fault Locator

NTDS "A" Link Fault Location Procedure and Facilities: a. Primary System Test Loop. b. Radio System Auxiliary Test Loops for Fault Location. c. Data Terminal Auxiliary Test Loops for Fault Location.

and tactical traffic, in ever increasing volume, must be carried regardless of conditions. The limited electromagnetic spectrum which we know how, or are permitted, to use has caused us to adopt more sophisticated designs.

What are some of the design features that must be considered? Reliability, maintainability, frequency stability, interference from man-made and natural causes, spurious radiation, versatility and cost are all important considerations. None can be ignored, nor can any hard and fast rule be applied as to their relative importance.

By reliability is meant the ability to operate over long sustained periods of time under any conditions that the ship can withstand. The normal shipboard environment in which electronics equipment must operate is one of severe vibration, high ambient temperature and corrosive salt air. During combat action, conditions are further aggravated by exposure to high impact shocks from today's weapons. What is a reasonable figure for the average time between failures? Is it 2000, 5000 or 10,000 hours? When do we reach the point where excess under-rating of components degrades performance? When does ruggedness result in intolerable weight or size or cost? Experience in these matters is accumulating and one day it may be possible to feed this experience into a computer and obtain definitive answers.

The performance of communications equipment is intimately related to the temperature to which certain critical components are exposed. The experienced designer can avoid some of the trouble during the preparation of his layout by isolating heat generators from sensitive components. The biggest single improvement to date in heat reduction is through the use of transistors in place of thermionic tubes. Heat which is not generated does not need to be removed. Forced air can be used in many cases to cool trouble spots. Great care must be exercised to assure that in cooling one component or sub-assembly that heat conditions in another area are not aggravated. In extreme cases, water cooling must be applied. Specifications for equipment and components give the limiting temperatures but do not specify the means to be employed.

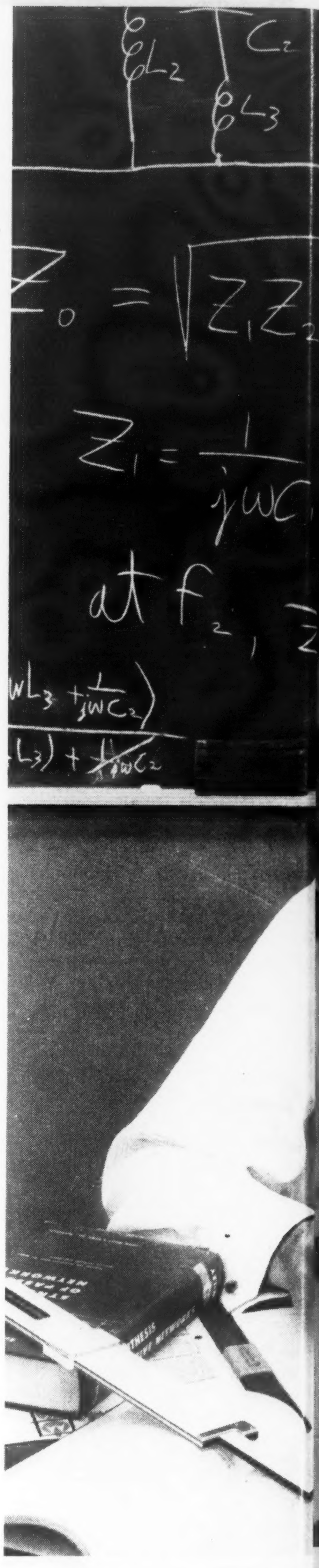
Maintainability involves the overall assessment of the maintenance requirements to insure maximum "up time" of equipments. It includes accessibility, interchangeability of parts, test equipment needed, storage and cost of parts, training of technicians and precision of adjustments. Maintaining modern communications equipment is a most demanding task and a continuing problem. Maintenance difficulties have in the past given rise to the maxim, "If it works at all, leave it alone." This represents a defeatist attitude and reflects unfairly on the abilities of the many dedicated and expert technicians in the service who actually maintain our complex equipments. The fact remains, however, that there are not enough of these men available. The long period of training and the enticing opportunities in industry shorten the time during which a man is available. That is why so much effort is being spent on reliability, accessibility and simplifying the search for troubles when they do occur. Today this search for trouble takes about 75% of the equipment "down time."

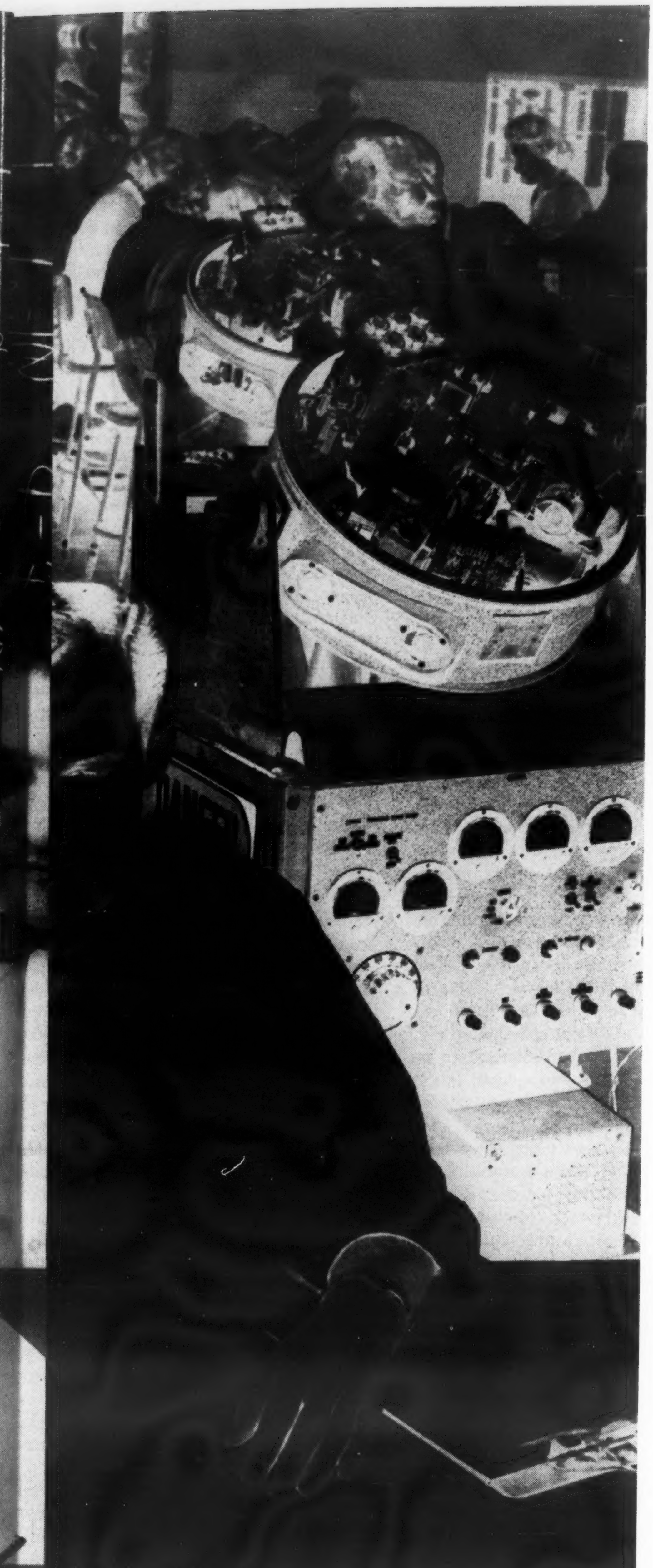
Figure 1 shows a type RBC Communications Receiver installed during the early part of World War II and still in operation. It illustrates the unit construction prevalent at that time. Each component is a separate entity and must be tested or replaced separately. Access is poor, convenient test points are lacking, yet when in condition, the RBC still renders service.

The Navy Model RBC equipment is a general purpose, high frequency communications receiver having an external rectifier power supply to provide for its operation from conventional alternating current power sources. Its development was completed by a commercial electronics firm in 1940 and it was produced in relatively large quantities throughout the period of World War II and the Korean conflict. This equipment was specifically designed to afford a high standard of reliability of operation and performance for the reception of voice, continuous wave (CW) and frequency shift keying (FSK) signal transmissions under the rigorous environmental conditions experienced aboard combatant vessels of all types and classes. The fact that a large percentage of the total procurement of this equipment is still in active service attests to the high calibre of the electrical and mechanical design.

The receiver is designed in such fashion that its chassis may be pulled out from its cabinet for trouble shooting and electron tube replacement. Overhaul or part replacement require that the chassis be moved to a work bench. Although the chassis contains some sub-assemblies, such as shielded

(*Continued on page 52*)





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r.f. coil boxes, the basic mechanical design was predicated upon individual part replacement. Consequently, the size of the equipment was dictated, to a major extent, by the necessity for making all parts readily accessible for repair or replacement.

An advance in accessibility is illustrated by the AN/WRT-2 Transmitter, Figure 2, where the functions are compartmentalized, in separate drawers mounted in a rack. Each drawer may be pulled out while still operating and may be tilted and tipped as necessary for access. Still another design feature of this equipment is the integration of the wiring to each drawer into a single cable which is mounted in the rear section of the cabinet. This represents a definite advance in assembly and repair practices.

Figure 3 shows the AN/URC-32 Communications Set, which is the first large scale application of modular construction in the fleet. The 16 modules themselves are almost entirely miniaturized yet are repairable by forces afloat. The quick replacement of a module restores the set to operation in minutes. The technician then repairs the module in the repair shop under less stress and with ready access to any special tools and test equipment required. Considerable savings in space, weight, and cost accrue through the use of the three common modules. This set has been favorably received by the Fleet.

Stocking of Replacements

The stocking of replacement modules poses a problem somewhat similar to that faced by a New England football team scheduled to play on the West Coast. Transporting an unlimited supply of substitutes is unsound economically. Some players will be injured but which ones? No one can foresee. A quarterback who can pass, kick and run is a real asset. Likewise a tackle who can do the punting makes it unnecessary to carry a kicking specialist. So it is with the Navy, replacement modules must be on hand in sufficient quantity and variety to keep a set functioning. Repairable modules are necessary to keep the cost of stocks within bounds. Reserves are too far away to be useful in an emergency. The time has not come yet when throw-away modules are justified.

The next step in reducing down time is the introduction of automatic fault indicators. A blown fuse indicates trouble in a general area but what we envision is more specific. Here again considerable discretion must be exercised so that the complexity, size, weight and costs involved do not overshadow the gains in locating faults. A fault locating device is under development for use with the AN/WRT-2 equipment of Figure 2. This device will be a rotary switch which will indicate malfunctioning of a specific circuit.

It is not sufficient to be able to pinpoint a failure. Some indication of the gradual degradation in performance is needed so that adjustments may be made to restore efficient operation. Such a system is diagrammed in Figure 4.

Test Method

The function concerning intralink fault location and detection for NTDS (Naval Tactical Data System) "A" Link is one of signal tracking. Either an artificial test signal or actual data may be used as a signal source, depending on circumstances of the test. The test method is designed as follows:

(1) A rapid check on the over-all system operating condition. If this check indicates a failure, then two auxiliary tests may be performed to isolate fault. The accompanying figure 4 illustrates these two cases. Test loop (a) encompasses the complete transmit-receive path (excluding antennas) and provides a continuing monitor of system performance. This check can be executed without interruption of normal operation. Test loops (b) and (c) are designed to locate faults detected by test loop (a) in the radio and terminal respectively. Test signals and/or programs may be injected into each loop and faults can then be isolated by the process of elimination.

Any given piece of equipment may function perfectly when isolated from outside disturbances. How it performs on shipboard, operating in close proximity to many sources of interfering radiation is the real test of effectiveness. Moreover, its own design must not generate signals which degrade the performance of adjacent equipment. This characteristic of a design is just as important as the selection of a crew for submarine duty. No matter how competent a man may be, his ability to work in harmony with his fellows in the confines of a submarine and his reactions under stress are of transcending importance.

There are other factors which influence the design of general purpose communication equipment. First, it must be compatible with equipment now in service. We are just now beginning to consider designs having single sideband capability exclusively. In the interim, equipment must also have AM capability. The cost involved in replacing obsolescent systems Navy wide is so great that it must be spread over a period of years. Moreover, training and installation facilities could not handle the massive assignment occasioned by an overnight switch over to a new system.

Another design factor of increasing importance, as it becomes better understood, is that of value engineering. As the name of the program implies, it consists of designing more value into the product. In this program, the Bureau relies heavily on the ingenuity of industry and offers suitable rewards for achievement. The elimination of frills, use of standard parts to reduce the need for special tooling, reduction in weight and size, use of less expensive materials and many other elements can be considered a part of value engineering. Recently the joint consideration of value engineering and quality control was initiated. Many contractors have now established adequate quality control procedures. Industry-wide acceptance of such procedures could lower requirements for extensive control features in specifications.

What can we expect in the future? Is there a future for general purpose communications or will all shipboard communications be handled by special purpose equipment? The trend is certainly toward more and more use of special purpose systems, yet the work horse of the fleet will be general purpose systems for some time to come. We can look forward to nearly complete transistorization within a short time. The multiple use of elements such as the tunnel diode is under consideration. Micro-modules constructed on automated assembly lines offer intriguing possibilities yet appear to depend on a higher degree of standardization than is current and upon procurement in larger quantities than present schedules permit. The high stability of frequency, characteristic of our newer equipment, must be extended to make possible the use of additional channels. Wider application of parametric amplifiers is to be given support.

The exploitation of any or all of the above techniques is dependent upon the degree to which communications service, reliability, maintainability, form factor and cost can be improved thereby. However, we will move as fast as is reasonable in any new area which promises improvement.

Protection of life and property at sea is a major responsibility of the United States Coast Guard. To help attain this objective, the Coast Guard maintains comprehensive aids to the navigation program of which Loran constitutes an important part. Over the years, our service has expanded and improved the Loran network until it now embraces a large part of the world's water surface.

Legal sanction for the operation of the Loran system is provided by Section 81, Title 14, of the U. S. Code which authorizes the Coast Guard to ". . . . establish, maintain, and operate: . . . . (3) Loran stations (a) required to serve the needs of the Armed Forces of the United States; or (b) required to serve the needs of the maritime commerce of the United States; or (c) required to serve the needs of the air commerce of the United States as determined by the Administrator of the Federal Aviation Agency."

Under this authority, the Coast Guard has undertaken the implementation of the Loran-C system to provide wide area, marine navigational coverage of the highest accuracy commensurate with the present state of the electronics art.

Vice Admiral Alfred C. Richmond, USCG
Commandant of the United States Coast Guard

modern loran navigation for the mariner

by Commander Harold T. Hendrickson, USCG

When Marco Polo returned from the Orient with a magnetic compass, he provided the means whereby coast-bound sailing craft could proceed by direct paths between ports of call of the old world. Since those days the art of navigation has long since evolved into a science, and the means for aiding the navigator to determine his position have progressed from makeshift visual devices through self-contained inertial guidance systems.

Since its inception in 1790, the U. S. Coast Guard has been intimately connected with the establishment and maintenance of navigational systems on and over the navigable waters of the United States, the high seas, and in those areas of the world in which military operations require navigational assistance. The Coast Guard has witnessed and supported technological progress in the navigation field and has seen the colonial bonfires and booming cannon on Beacon Hill turn into a precise optical light and automatic foghorn in the Boston lighthouse of today. It has seen the stave barrels anchored at entrances to coves and harbors turn into an extensive system of buoys, markers, and signals marking the channels and waterways of our country and its possessions. It has seen electronic navigation emerge from its infancy, when in 1921 the first marine radiobeacon in the United States was placed in operation at the entrance to New York harbor, and grow to the present lacing of the world with Loran lines of position.

The Loran system is a pulsed, hyperbolic navigation system, wherein the time difference between received synchronized radio pulses transmitted from two widely spaced stations is measured to a high degree of accuracy by the user's receiver-indicator. Since radio waves are propagated with the speed of light, the time difference represents the actual difference in distance of the position of the receiver from the two transmitters. By definition, the locus of points with a constant difference in distance from two reference points is a hyperbola. Thus, the time difference represents a hyperbolic line of position which can be compared with predicted values plotted on a chart. When time delay readings are obtained from two pairs of stations, the resulting hyperbolic lines of position intersect to form the Loran fix.

Loran, born in World War II, has come of age in Loran-C. Loran-C frequently is referred to as "low-frequency" Loran or "cycle-matching" Loran. Loran-C encompasses differences and advantages over its earlier relative, Loran-A. Where Loran-A merely matches the envelopes of the radio-frequency energy pulses transmitted from a pair of Loran stations to obtain the hyperbolic line of position, Loran-C matches the cycles within the radio-frequency pulses to obtain much more accurate fix information. Where Loran-A energy is transmitted in the two-megacycle region, Loran-C drops to 100 kilocycles in order to provide fix information at much greater distances from the transmitters. Reduction of the frequency permits the synchronization of the transmissions from a Loran pair over greater distances between the stations for the same radiated power. The greater distances between stations improve the crossing angles of the lines of position and thereby increase the geometric fix accuracy. Additionally, because signal attenuation over land is less at the lower frequency, Loran-C service can be extended over large land masses which cannot be covered by Loran-A. Finally, by using time-sharing techniques, Loran-C stations are operated on the same basic frequency in all areas, and on the same pulse repetition rate in any one area. This compares with three basic frequencies for Loran-A in all areas, and at least two pulse repetition rates in any one area.

The first five of the differences mentioned above result in outstanding operational improvements to the user. The reduction in frequency spectrum used for the navigational fix information brought about by time-sharing portends the extensive use of Loran-C as a wide-area, long-range navigation system.

In making such a prediction, one must consider the immediate future requirements of a long-range navigation system as well as the ultimate requirements, since a certain lead-time is necessary to establish any large area coverage system. In 1921 few foresaw the use of the radio beacon and range as the primary navigation device for the airways of the 1930's

and 1940's. A 20-year lead-time was required to establish the basic network. Scientific advances, which demand consideration of tomorrow's space vehicle, have shortened the lead-time; however, to peer too far into the future may leave us without operational hardware for today. The development of Loran-C is a good example of the time required between the inception of a navigational idea and the nurturing of this idea to the operating stage with fully developed user equipment.

In 1944-45 the United States investigated the feasibility of providing navigation information by means of a low frequency Loran network. The frequency chosen was 180 KC/S. Three stations were built in the United States for evaluation.

In 1946 an arctic expedition was provided with low frequency Loran service. Although the system experienced difficulties and ranges and coverage area were not as great as expected, great benefit was realized from the vast amount of data gathered. The usefulness of this system was seriously affected by the inability to resolve ground and sky wave propagation modes with the equipment techniques then available.

Commencing in 1945 the United States Air Force began investigating a tactical system known as Cyclan. It utilized continuous-wave emissions on frequencies of 180 KC/S and 200 KC/S. In 1951 the Cyclan program underwent a change—principles of pulsing and phase coding were added, and the name Cytac became associated with the program. A part of the Cytac program was a high-precision navigational system operating on 100 KC/S. Evaluation of the system during the period 1952-55 indicated that the equipment was capable of providing navigational position data of high accuracy over a large area.

In 1956 the United States Coast Guard carried out 100 KC/S radiation tests and assumed responsibility for investigation of the high accuracy navigation potential of the navigational component of the Cytac system. The transmitters were relocated to the Atlantic Coast and the name of the program was changed to Loran-C. The three stations are today providing high accuracy navigational service over the middle Atlantic Ocean area.

"Loran-A," "Loran-B," and "Loran-C" are the three systems of Loran currently operating. Loran-A (formerly known as standard Loran) is the Loran system operating in the 1.8-2.0 MC/S band and using a "coarse" time difference measuring technique to obtain a time difference reading. Loran-B also operates in the 1.8-2.0 MC/S band but uses a "fine" time difference measuring technique. Loran-C operates in the 90-110 KC/S band and uses a "fine" time difference measuring technique. Basically all three systems are the same, the major differences being in frequencies and time measuring techniques.

In the Table below some characteristics of each Loran system are listed. The Table is not a comparison of one system against the other, but rather illustrates the similarity of the three systems. Selection of the Loran system to be used in a geographic area is governed by the navigational requirements for that area.

Characteristics of Loran Systems

	Loran-A	*Loran-B*	*Loran-C*
Frequency Band	1.8-2.0 MC/S	1.8-2.0 MC/S	90-100 KC/S
Receiver Bandwidth	35 KC/S	35 KC/S	20 KC/S
Basic pulse repetition rate (Pulses per second)	20, 25, 33⅓	20, 25, 33⅓	10, 12½, 16⅔ 20, 25, 33⅓
Number of specific rates for each basic rate	8	8	8
Group pulsing	No	No	Yes
Phase coding of pulses	No	No	Yes
Peak power	100-1,000 kw	200 kw	100 kw
Nominal ground wave range over sea water	700 nautical miles	200 nautical miles	1200 nautical miles
Nominal standard deviation	1 microsecond	.01 microsecond	0.1 microsecond
Signal to noise ratio required to operate	3:1	10:1	1:10
Sky waves useful	Yes	No	Yes

The quality of a Loran navigation system is dependent upon several factors which can be divided into two categories—(1) the geometric configuration of the hyperbolas defining the system, and (2), the precision of the time difference measurements. Once the stations in a network have been located, the geometric configuration is established and will not change for that particular network.

In regard to time difference measurements, it has been found that the velocity of propagation of the radio ground wave is affected by the nature of the earth's surface and by changes in weather conditions. The variant in the travel time of the propagated ground wave from the transmitter to a point in the service area is called "the secondary phase factor." If propagation is over a homogeneous path such as sea water, the conductivity of which remains relatively constant, an accurate prediction of the secondary phase factor correction is possible. This correction is applied to the Loran charts and tables at the time of their preparation, and need not concern the navigator. If the path of propagation contains considerable lengths of terrain whose dielectric characteristics change with heat, humidity, and weather factors, the additional variations may, if the time measurement is sufficiently sophisticated as in Loran-B and Loran-C, become significant. These variations can often be minimized by careful selection of the transmitting station sites to provide a propagation path as homogeneous as possible from the transmitter to the receiver.

In the Loran-C system of operation the transmitter synchronizers can maintain system constants accurately to the order of 0.1 microseconds. The predictable velocity variations of the ground wave over sea water are applied in the preparation of the Loran-C charts and tables. Secondary phase factor corrections for ground wave propagation over land areas are tabulated separately. The remaining factor in the determination of a line of position is the receiver's ability to measure accurately the time difference between the arrival of the Loran-C signals. If the receiver in the service area of a Loran-C network receives a good signal relative to the noise level (signal to noise ratio of 2:1), it can measure the time difference to an accuracy of the order of 0.05 microseconds. If the signal to noise ratio is 1:10, the receiver's ability to measure time differences is of the order of 0.25 microseconds. Thus Loran-C can provide useful navigational information under conditions considered too poor for Loran-A operation.

The United States Atlantic Coast Loran-C network consists of one master station, two slave stations, and monitor stations which insure the transmission of accurate navigational information. Equipment at the transmitting stations maintains synchronization of the signals to the order of 0.1 microseconds. It was predicted that this network would be capable of providing navigational fix information to an accuracy of plus or minus one-fourth of a nautical mile for a distance of 1200 nautical miles

(*Continued on page 55*)

Loran Navigation

(*Continued from page* 54)

utilizing the ground wave signals.

During 1958, evaluation operations conducted in the service area of the Atlantic Coast Loran-C network demonstrated that the ground wave is useful to a range of approximately 1300 nautical miles. The evaluation also showed that navigational fixes to an accuracy of one-fourth of one nautical mile are obtainable 95% of the time.

Additional navigational information is furnished to areas beyond the ground wave service area by Loran-C sky waves (radio waves which are reflected off the ionosphere back to earth). These waves are further described as one, two, or three hop, depending upon the number of times reflection occurs between the transmitter and receiver. Since sky waves travel a longer path to arrive at a point in the service area than the ground waves do, a correction factor must be made to sky wave readings. Tabulated corrections are applied by the navigator when using the sky wave propagation mode.

The 1958 evaluation indicated that Loran-C first hop sky waves are useful to approximately 2000 nautical miles during the day, and to a range of 2300 nautical miles at night. Multihop sky waves were received at night to a range of approximately 3400 nautical miles. The stability of sky waves is of the order of plus or minus one microsecond except during periods of sunrise and sunset when accurate use of the sky wave propagation modes is not possible with present knowledge. During periods of normal operating conditions and within range of the first hop sky wave, it is possible to obtain a line of position accuracy within the service area of approximately two nautical miles for 95% of the time.

The probable error of Loran-C navigational fixes results from the errors contained in the time difference measurements. A sizable portion of this error is contributed by the Loran-C equipment. The results discussed in the foregoing paragraphs are based on evaluation of the United States Atlantic Coast network which operates development model equipment more than 10 years old. Newer and better instrumentation techniques reduce the equipment errors, and Loran-C networks of the future should perform more accurately under the same environmental conditions. A three-station chain located in the Mediterranean area commenced operation during the late Spring of 1959. Evaluation of this chain has verified the first predictions.

The terminology describing the power output of a Loran transmitter indicates the power that the transmitting station would be radiating if the signal consisted of a continuous sine wave which matches the largest radio frequency cycle of the pulse. Loran-C pulse groups are transmitted in accordance with one of the recurrence rates listed in the table appearing in this article. Simply stated, this means that the transmitter radiates a group of pulses and then rests for a relatively long period of time. The average power radiated by a transmitting station labelled as "100 kilowatt peak" is about 2 kilowatts.

Loran-C receiving equipment now in use presents continuous navigation information by electrical signals and/or mechanical shaft rotation of readout dials. This equipment has the capacity for other visual presentations by use of automatic computing and display devices.

The list of potential applications of Loran-C has continued to grow since its accuracy of the order of 0.1 microseconds has been operationally demonstrated. The great stability of the transmissions has made it a contender as a worldwide timing device. The large day and night range of stable ground and first hop sky waves have made it attractive for the generation of pictorial positional data in high speed aircraft. This was foreseen early in the development of user equipment and the outputs were accordingly designed to be unambiguous, continuously rotating, and with output torques in excess of one dyne centimeter. These outputs can also drive appropriate converters for either Rho Theta or latitude and longitude presentation.

The National Academy of Sciences has indicated that the oceans are one of our great unexplored natural resources. Position at sea is one of the parameters needed for exploration of these areas. Loran-C can provide these parameters to an accuracy and range that has not heretofore been possible.

Loran-C receiver-indicators are now under manufacture by three United States companies. As more receiver-indicators become available it can be safely predicted that Loran-C will become one of the most useful navigational and scientific tools of the space age.

Marine Corps

(*Continued from page* 43)

to be introduced, is a lightweight, highly portable, moving target indicator which is capable of detecting enemy personnel and vehicles. This latter device will be used to supplement, and in some cases, replace observation and listening posts. Together, the two equipments will contribute to the operational requirement for all-round, 24-hour, all-weather electronics detection of the enemy.

Another interesting Marine Corps development is known as BASICS (Battlefield Area Surveillance and Integrated Communications). Data techniques are being used in this system. Reduced to its fundamentals, BASICS equipment consists of numerous hand-held message generators, a memory drum, a Flexowriter, and a display tube. The message generator permits an observer to register information, check his work for accuracy, and press a switch for burst transmission of his digital message over the standard Fleet Marine Force communication network. Figure 4 shows BASICS Message Generator. The message is received at the command post, stored in the memory drum, printed in hard copy by the Flexowriter, and recreated on the display tube. The intelligence officer is presented with timely information for evaluation, processes it into intelligence, and quickly passes the information to the commander. BASICS can also be adapted to a variety of other uses, such as fire support and logistical support. However, at present, evaluation of BASICS is being confined to its operational suitability for faster collection and interpretation of information.

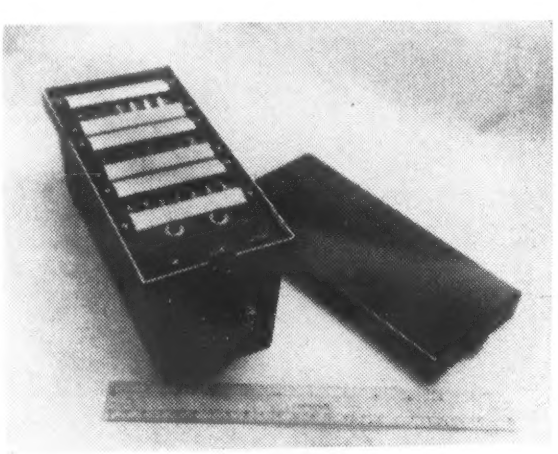
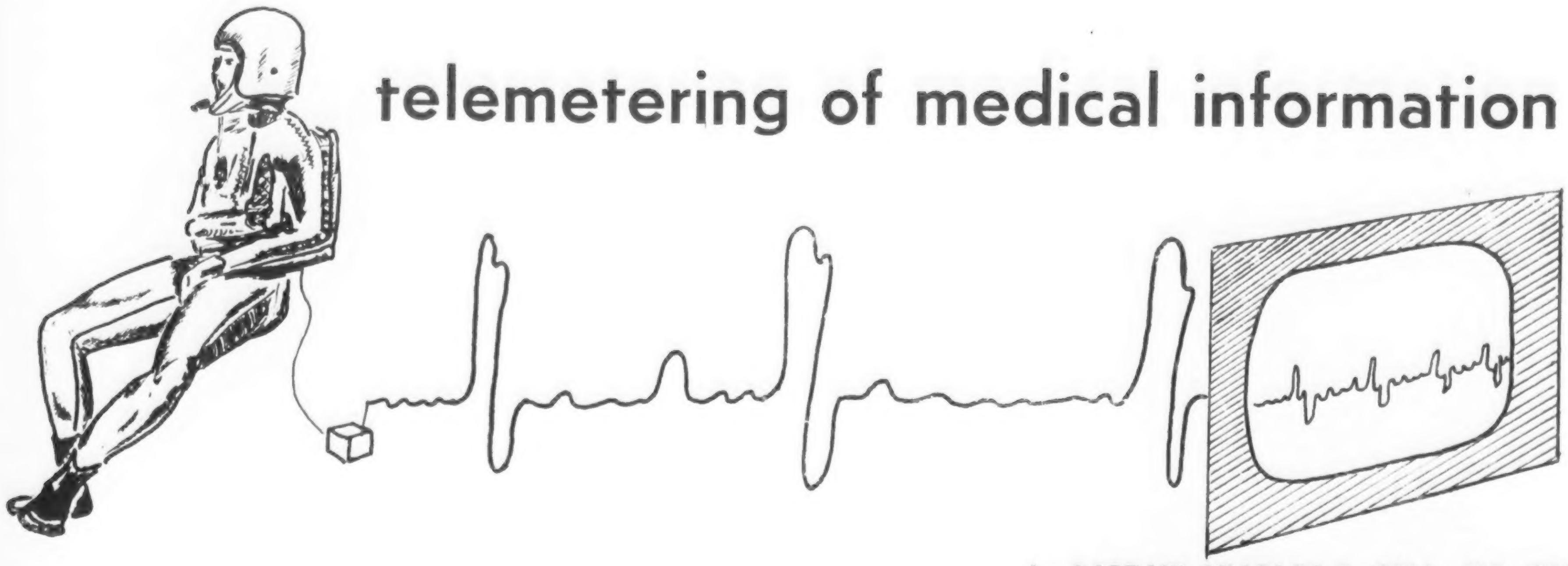


Figure 4.

The Marine Corps, together with the other Military Services, is always striving to develop more efficient and effective techniques and equipment to increase combat capabilities. As the Marine Corps changes from the old to the new, however, readiness posture is maintained. Marine Corps units will fight with whatever is on hand.



telemetering of medical information

by CAPTAIN CHARLES F. GELL, MC, USN
SPECIAL ASSISTANT FOR MEDICAL AND ALLIED SCIENCES
AND LOYAL G. GOFF, PROJECT OFFICER FOR APPLIED PHYSIOLOGY

THE ART OF COMMUNICATION is perhaps the most fundamental of human accomplishments, insofar as social development and mass education of mankind are concerned. The earliest efforts at communication were by means of grunts and snarls which, later, led to the spoken word. Realizing the limitation of the speech range, even though it was amplified by shouting, man has continuously sought a means of augmenting the range of his communication.

There has been steady progress in the development of improved communication methods since the advent of the first amplifying aids, which probably consisted of pounding on hollow logs or bellowing through animal horns. This progress undoubtedly paced the humanizing aspects of brute man. When the means of communication by electrical impulses through wires and later by radio waves was developed, communication possibilities became world wide and the peoples of the earth were knitted together more closely. As the external aspects of communication became electronically more sophisticated, the biologist began to look with interest upon these amplifying methods as a possible means of communicating information on the inner workings of man's physiology to an investigator with greater accuracy and discernment than heretofore possible. The early electronic equipments used in radio communications were too cumbersome, however, and actual utility had to wait for later refinements. With the present day development of transistors, microcircuitry and miniaturization, the opportunities for electronic investigation of biological phenomena have increased correspondingly.

The earliest methods of transmitting biological information from internal man to an investigator were rudimentary and slow to improve. Laennec's stethoscope was invented in 1819 and prior to this the doctor listened to chest sounds by pressing his ear against the patient. Later, the stethoscope evolved from a hollow tube to a device with a diaphragm pickup, thus, enabling the physician to hear and differentiate between heart and breath sounds, as well as other internal visceral movements. Later, development of the blood pressure cuff and kymographic recordings improved the accuracy of interpretation of physiological noises, but it did nothing to increase the range of transmission from the source to the receiver.

As biological information related to electrical phenomena in the human body accrued, the application of electronic methods continued. When it became known that the electrical patterns of functioning organs could be isolated and interpreted, the electrocardiograph and, later, the electroencephalograph were developed. Today, a great many pressure factors, sounds and electrical variations can be transmitted from within the body to the external environment through the medium of transducer tipped catheters, internal and external implanted electrodes and devices for picking up surface pressure, electrical, and thermal changes.

With these physiological electronic devices at his disposal and with the development of miniature transmitters, the imaginative biologist began to consider ways of securing biological information from inaccessible subjects and from those located in remote places.

The avenues of investigation that became possible through the use of telemetering biological information were many and varied. Typical of these were those concerned with natural history, where the biologist saw an opportunity to follow the life functions of wild life in its natural habitat. The physiologist and clinical medical researcher saw their opportunity in the study of subjects in motion and under no direct observation, thus, insuring no emotional or psychological response. The medical practitioner envisioned the utility of telemetering in the possibility of transmitting information directly from a patient to a specialist for diagnostic consultation. Perhaps the most publicized use for telemetering has been in the aerospace medical field where physiological and biochemical information has been telemetered to ground and airborne monitors by the operators of airplanes, high altitude balloons and subjects in space probes. Telemetering of medical information will certainly be a highly necessary adjunct to space flight especially in its early developmental stages: first, to gather information as to the various stressor effects of space on biological systems and, secondly, to monitor and protect the man, himself, in space.

In reviewing the telemetering work in natural history sponsored by the Office of Naval Research, interesting and informative data come to light. Just as in the human, animals are also susceptible to the presence of man, both emotionally and biologically. Even in such a complacent animal as a cow, human presence invariably results in an increased blood pressure and heart rate. Therefore, if the normal metabolic functions of

(*Continued on page 66, col. 3*)

by CAPTAIN J. M. PHELPS, USN
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SHIPBOARD ANTENNA SYSTEMS

At first glance it would seem impossible to design an efficient antenna system for a Navy ship. The design objectives appear to present many conflicting and unattainable goals. These goals are now, however, being reached by the application of "Electronic Architecture"—the parallel and coordinated development of antennas and ship structure.

One of the most difficult shipboard antenna system design problems is the MF/HF communication antennas which operate in the frequency range of 300 KC to 30 MC. Vertically polarized, the antennas are used to propagate ground waves and sky wave energy to ranges as great as several thousand miles.

The long wavelengths of the HF range require the use of unbalanced antennas for shipboard use. They are fed by coaxial transmission lines at various places about the ship's structure, usually some distance from the water. The current flow in an unbalanced antenna under these conditions is very complicated. Current is not restricted to the so-called "antenna," or wire comprising the antenna. Portions of the current flow on the conducting ship's structure and on the ocean surface. Currents flowing in the antenna also induce other currents on the ship's structure and in nearby antennas. These currents can cause inherent limitations in the radiation properties of shipboard antennas that cannot be overcome by conventional techniques.

When currents flow on a vertical portion of the ship's structure it automatically becomes a part of the radiating element. The current induced upon it radiates just as the current in the antenna radiates. Most shipboard HF antennas are required to radiate omnidirectionally. When the radiation resulting from currents flowing on the ship's structure is uncontrolled it can adversely add to, or subtract from, the desired radiation from the antenna. When this happens omnidirectional coverage is not achieved.

The amount of current that is induced upon a vertical portion of the ship's structure by an antenna depends upon many factors. These include the heights of the structure and the antenna, the diameter of the structure, the separation between structure and antenna, in terms of wavelength, and their positions with respect to each other. Under proper conditions the current induced in the ship's structure can be almost equal in magnitude to the current that is flowing in the antenna. This condition is frequently met in practice due to the large frequency range over which the antennas must operate.

The current induced in a grounded parasitic structure is generally quite small until the structure becomes about 0.1 wavelength tall. A peak of induced current is reached when the structure height approaches 0.25 wavelengths. Beyond this height the current reduces. A second peak is again reached when its height approaches 0.75 wavelengths. The relative magnitude of the current peaks observed when the structure approaches odd quarter-wavelengths in height depends greatly upon its spacing from the driven antenna and its length-to-diameter ratio. The fatness of the structure is related to its "Q" and, hence, to the sharpness of its response as its electrical height varies. Tall thin structures are characterized by pronounced current peaks of large amplitude near the resonant heights. Fat structures produce more moderate effects over much wider variations in their electrical height.

The characteristic silhouette of Navy ships is comprised of a multitude of vertical grounded conductors. They range in height from a few feet to as much as 200 feet. Mast heights of 100 feet are common on ships as small as destroyers. For these mast heights serious effects on the antenna radiation patterns would be anticipated for frequencies near 2.5 MC. At this frequency the mast would be approaching quarterwave resonance. These effects are experienced in practice and serious distortion of radiation patterns is encountered when the spacing between the antenna and the

Fig. 1—Brass scale model (1/48 scale) utilized on Navy Electronics Laboratory model range. Brass is used because of malleability, resistance to rust and corrosion, low cost, and requisite technical parameters.

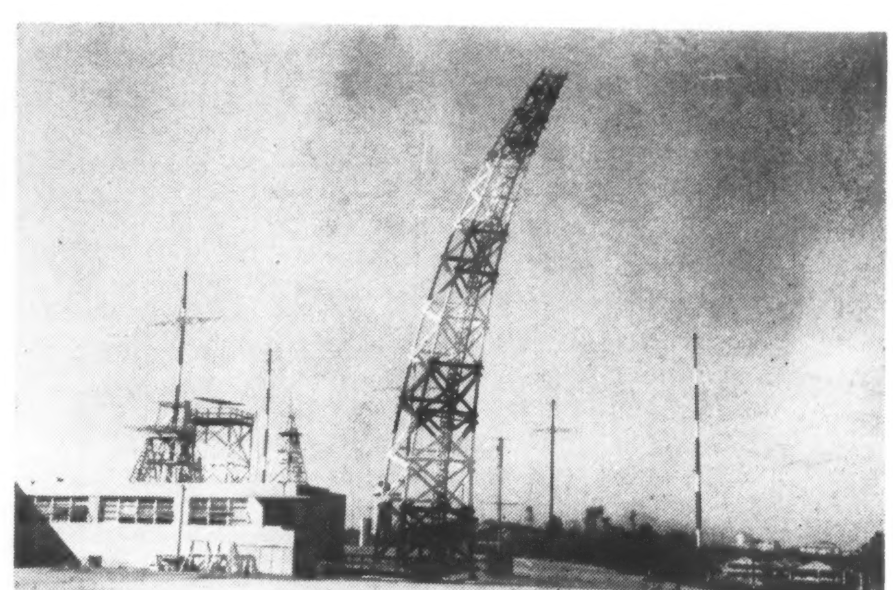

Fig. 2—Partial view of Navy Electronics Laboratory ship model antenna range, showing 160-ft. diameter ground plane (bottom center); turntable, with 1/48 scale model (lower right); 80-ft. radius Zenith wooden arch (center).

mast is sufficient to permit addition and cancellation of their radiated fields. When the antenna is quite close to the mast, its effect can be manifested by a large reduction in net radiated power or impedance variations rather than by nulls in radiation coverage. Similar effects are caused by the stacks and other appurtenances at higher frequencies where wavelengths are smaller. Usually there are overlapping effects. The resulting radiation is a combination of radiation from the antenna and from the masts, stacks, deck houses, cranes, guns, boats and boat davits. Pattern distortion is experienced over the entire frequency range of interest.

At the higher frequencies it is sometimes possible to install an antenna sufficiently far away from potential reradiating structures to prevent major radiation distortion. If a separation of a wavelength or more can be provided between the antenna and the structure, moderate effects can usually be obtained. This can be accomplished at 20 MC, for example, where a wavelength is approximately 50 feet. It is not feasible, however, at 2 MC where the wavelength is approximately 500 feet.

The 2-to-6 MC frequency range is of prime importance to Navy shipboard communications. These frequencies provide ground wave coverage for tactical and operational usage. Omnidirectional coverage is essential for the successful accomplishment of these functions. In this frequency range the masts and stacks cause their severest effects on the patterns of ship antennas. These effects must be controlled and used beneficially in system design. The simplest way of exercising the necessary control is to unite the antenna and the parasitic structure into a single radiating element. Omnidirectional coverage is obtained from this single source of radiation.

Usually it is possible to provide only one 2-to-6 MC antenna having omnidirectional characteristics. However, more than one circuit is required in this frequency range by all ships. Transmitter couplers are available to enable the simultaneous use of a single antenna by several transmitters. For acceptable coupler efficiency the antenna must have broadband impedance characteristics. A 3:1 VSWR (voltage standing wave ratio) on a 50 ohm line at all frequencies is usually required. Conformal antennas, integrated into a ship's structure, are designed to provide these characteristics over a 3:1 frequency range.

The design of antennas of this complexity requires an intimate knowledge of the electrical characteristics of a ship's structure. Due to the large number of parameters and unknowns involved, experimental methods must be employed. This can be accomplished rapidly, economically and accurately with scale models. Unique ship model range facilities are used at the Navy Electronics Laboratory, San Diego, California for these studies.

Complete ship models are constructed for the 2-to-30 MC studies. These models are constructed to 1/48 scale (1/4 inch equals 1 foot). This scale factor has been selected for ease in construction and to utilize available electronic test equipment. Models are constructed of sheet brass, complete in all topside external details. See Figure 1.

The ocean is simulated by a large, unobstructed, highly conducting ground lane. The center section of the ground plane is a flat metal turntable, 22 feet in diameter, for rotation of the models. The turntable will accommodate 1/48 scale models of the largest naval vessels. Surrounding the turntable is a level, circular asphalt-concrete field, 160 feet in diameter, covered with a thin coating of sprayed lead.

To record an antenna directivity pattern, a continuous signal is sent to the model from a source antenna at the edge of the field. The model antenna under test is connected to a receiver from which an audio output is obtained. The magnitude of the audio signal is used to control the deflection of a pen on a polar recorder, the turntable of which is rotated in synchronism with the revolving model so that signal strength amplitude is plotted as a function of bearing. This plot is a characteristic of the ship antenna and it is applicable regardless of whether the antenna is used for transmitting or receiving. Azimuth (ground-wave) patterns may be plotted by transmitting signals from a parabola located on the ground at the edge of the field. Zenith coverage patterns may also be taken, to an elevation of 65 degrees above the ship, by transmitting from a source antenna traveling up the face of an 80 foot radius wooden zenith arch located on the edge of the field. See Figure 2.

The lead-covered ground plane and turntable were carefully designed to eliminate variances in directivity patterns caused by discontinuities within the field. The periphery of the field is sharply scalloped to reduce standing waves which might be produced by reflections from the outer edge. The turntable was designed with an overhanging lip which turns within a trough in the ground plane, providing capacitive coupling to maintain continuity. Discontinuities between the ship model and the turntable are eliminated by soldering the model to the turntable.

Antenna pattern measurements are used as the first step in the design of a shipboard antenna system. Tests are made to determine the inherent electrical characteristics of the ship's structure. Where necessary, portions of the structure are removed and assembled in a step-by-step fashion to identify and isolate individual effects. Analysis of these tests determines which portions of the ship's structure must be included in the development of antennas required to meet operational needs.

Usually more than one element of superstructure must be included in the development of an antenna. For example, on a destroyer it is necessary to include both the tall mast and the stacks in designing a 2-to-6 MC antenna. The radiation patterns for an antenna of this type can be estimated with reasonable accuracy. Impedance characteristics, however, are greatly influenced by antenna configuration and environment and cannot, usually, be estimated with sufficient accuracy.

Impedance studies are made with the scale ship models to develop the antenna configurations. Upon completion of these studies the radiation patterns are measured to confirm that they are within design limits. For existing ships it is sometimes necessary to relax design limits. Antenna performance is governed by basic physical laws. When ship structure is not in conformance with these laws optimum antenna design is not possible. Extensive revisions of existing structures is frequently too costly or impractical to effect.

Significant improvements are being accomplished in existing ships by integrating antennas into their structure. Within the basic limitations of their environment, these antennas provide optimum performance. Other techniques also are being used to improve antenna system capabilities. For example, broadband receiving antennas are being installed atop gun turrets to provide reduced interference and improved efficiency and radiation coverage. Similar installations for UHF ship-to-air communication antennas enables antenna installations at the optimum height above water.

For long range sky wave communi-

(*Continued on page 63, col. 3*)

COMMUNICATIONS FOR COMMAND CONTROL IN AN AMPHIBIOUS ASSAULT

by VICE ADMIRAL G. C. TOWNER, USN
COMMANDER AMPHIBIOUS FORCES, ATLANTIC

AMPHIBIOUS WARFARE integrates virtually all types of ships, aircraft, weapons and landing forces in a concerted military effort against a hostile shore. Current tensions in the world are such that the employment of Amphibious Striking Forces in limited or cold war incidents is an ever-present possibility. As Admiral Burke expressed it, "There is no single element of the National War capability more essential than the ability to put modern marine forces ashore immediately after a limited aggression starts."

The amphibious operation is a complete operation within itself. This includes planning, embarkation of troops and equipment, rehearsals, movement to the objective area, final preparation of the objective, assault landing of troops and accompanying supplies and equipment, and support of the landing force until termination of the amphibious operation. The closest cooperation and most detailed coordination among all participating forces are essential to success. The zenith of the operation is the assault; at this point the demands on our communication systems are heaviest.

I would like to state that I have confined my remarks herein only to the naval side of the picture. This is just half the story. The Landing Force communications are equally necessary for a successful assault. The Navy and Marines, since they constantly train together, are now a well integrated, highly coordinated team. However, when the occasion arises for the Navy, Army and Air Force to plan and conduct a joint amphibious operation, I am repeatedly gratified at our common understanding of communications and the compatibility of techniques and equipment. We have made great progress in this field. Joint procedures, standards and schools are paying off.

It is said that the three main components of military tactics are flexibility, fire power and the ability to command. The modern amphibious assault illustrates these principles to the highest degree. The ability to command now depends upon the ability to communicate rapidly. This must begin aboard the flagship of the Amphibious Task Force Commander.

Aboard the Flagship

The commander must have the proper communications to control his highly complex force. He normally has at his disposal a floating radio station. This is the Amphibious Force Flagship (AGC). The *Taconic* (AGC-17) recently was sent to the Indian Ocean to insure adequate communications in connection with the President's overseas trip.

Early in World War II, Admiral Hewitt maintained his flag aboard the heavy cruiser *Augusta* during amphibious operations in the Mediterranean. However, this ship proved too small, the facilities were inadequate, and positioning the ship for its part in naval gunfire support was incompatible with its command and communication duty. The AGC was then developed and the *Ancon* (AGC-4) was the first on the firing line available for operations in the spring of 1943. Today five of her type are still in the Active Fleet. Probably no other type of naval ship has undergone so many electronic modifications. During the Korean War these ships were equipped with some 71 radio transmitters and 192 receivers. Later, by careful re-analysis of our communication needs, and the combining or elimination of functional circuits and installation of more reliable equipment, we gradually reduced the electronic equipment aboard. During the Lebanon crisis these ships were able to meet communication needs with 50 transmitters and 90 receivers. However, to improve communications, the number of antennas had to be reduced. This has now been accomplished by use of UHF and HF multicouplers.

The space aboard the flagships where intelligence is received and displayed for viewing by the force commander is Flag Plot. Here tactical maps and charts show what might be a typical display of the disposition of our force on "D-Day" as it begins the attack on the enemy shore. The types of ships, numbers of aircraft and personnel will vary with the known enemy situation. Let us start from the beach looking seaward. The maps show Landing Ships Tank (LST) and Landing Ships Dock (LSD) moving in behind the assault boat waves in lanes previously swept by the minesweepers. Farther out is the transport area where the Attack Transports (APA) and Attack Cargo Ships (AKA) are debarking troops and equipment. Behind, in the heli-

Fig. 1—Supporting Arms Coordination Center—USS Mt. McKinley (AGC-7)

copter launching area, the helicopter assault ships (LPH) are launching and recovering helicopters. On the flanks are the destroyers and cruisers providing gunfire and missile support. Beyond are the carriers for fighter air defense and close air support. Protecting the assault from enemy submarines, the Hunter-Killer force stands by, with its carriers, destroyers and submarines. These are just some of the components that could be involved.

To weld this force into an effective team responsive to command takes communication planning, training and execution that is unrivaled in any military force. Today, large scale east coast exercises involve some 60 ships and the communication plans often show 130 operating radio circuits, without involving those of the Landing Force. Yet the battle for Iwo Jima included 450 ships and the Sicily and Normandy campaigns many more. Such numbers naturally greatly expand the links of command required. To prepare for such larger increase our communication plan must be so designed as to permit rapid expansion to handle changes in command relationships, task organization and disposition of forces.

Within the flagship the main areas for receiving and sending information are Flag Communications, Supporting Arms Coordination Center, Combat Information Center, and Radio Central. Internal teletype loops are used for the distribution of messages throughout the ship. Not only does this system insure rapid simultaneous multiple delivery to the proper spaces, but it also eliminates the necessity of breaking any water-tight integrity throughout the ship for hand delivery of messages.

The heart of the AGC, and responsible in a large measure for the success of the operation, is the Supporting Arms Coordination Center or commonly known as SACC (Fig. 1). This is normally manned by Tactical Air Control Squadron personnel along with gunfire and missile support coordinators. This group receives, evaluates and renders decisions on requests for air support and fire power. Communications are particularly sensitive in this area. The best equipment must be allocated, and the most experienced personnel assigned. Only then can we achieve the close timing and coordination essential during all phases of naval gunfire and air support operations. The possibility of atomic warfare demands greater control and greater communication requirements.

I might mention at this point the constant state of vigilance required to combat communication deception and jamming. Our proximity to a potential enemy may give him the opportunity to attack our circuits. Every operator in the amphibious force is trained to recognize and circumvent jamming or infiltration. Both the Navy and the Marines have units that are trained, prepared and equipped to simulate all forms of communication countermeasures. These units are always designated to participate in amphibious exercises and as a result the Amphibious Force is kept "on its toes."

After the exercise is over and the reports are in, I am amazed at the volume of traffic handled. But as I proceed throughout the ship and see the operators on such nets as the Task Force Commanders, Surface Tactical, Combat Intelligence, Tactical Air Control, Tactical Air Request, Beach Master Lateral, Boat Common, Fighter Air Defense, Naval Gunfire Control, Beach Reconnaissance, and Helicopter Direction, I am reminded that to do our mission successfully demands close control. Such control is only achieved by skilled communications.

As in all Naval Task Forces, communications in the Amphibious Task Force follows the chain of command. Control extends from the Amphibious Task Force Commander to the Group Commander down through the Squadron Commanders who are directly responsible for the ship-shore movement during the assault. The Group Commanders are normally embarked in an AGC and the Squadron Commanders in the APA Flagships. These latter ships have a slightly less communication capability than the AGC.

Additional control links must extend to supporting carriers, to friendly airfields, to the higher military headquarters and back to the major communication networks. All these requirements take careful allocation of equipment and personnel. Our plans must be tailored to what our communications can support. We cannot afford to "build in" poor communications. Therefore, the communication officer must be consulted on all phases of the operation plan.

Does command fail without communications? A military leader seated at his desk in Washington once stated, "Without communications I command nothing but this desk in front of me." Unit commanders in the Amphibious Force cannot place such exclusive reliance on communications for the exercise of command. There is no substitute for just plain initiative and common sense. Every plan must be so clearly written, that each commander can reasonably carry out his part even if communications fail. We must always be masters of and not slaves to our equipment. Computers will not replace command in the foreseeable future.

I would like to state what I hope to see in the future toward improving our Amphibious Communications, but before I do let me say that the Amphibious Task Force Commander is not merely concerned with communications in the objective area. The "enemy" could be in the Arctic, the Caribbean or the Mediterranean. It is very possible that it may be a long haul to the hostile shore. We would very likely be involved with carrier striking forces, with merchant ship escort problems, logistics, re-supply, intelligence gathering and distribution. Our plans must provide the proper communications; conversely, they must also provide for radio silence, if necessary. The technique of visual signalling can never be a "lost art" in the amphibious force.

Although the bulk of the amphibious personnel trained in World War II and Korea have left the active Navy, their experiences, successes, failures have brought combat-proven methods into the standard operating procedures of today. These methods are not static but are constantly being challenged. Each operation report is carefully scrutinized to strengthen command control. Every operation must have communications test objectives designed to improve upon what we have today. Communication Analysis Teams are sent on the exercises. The proven results from all these sources are now part of our Naval Warfare Publications and Landing Force Manuals, providing guides for the proper employment of communications. These techniques further form the basis of our present NATO publications. Combined operations are executed with such countries as Turkey, Greece, Italy, Nationalist China and many others with remarkable teamwork. This is due, in a large measure, to our common communication publications.

What Do We Need?

I realize that I am not fully aware at this level what the scientists and research engineers have in the books for the future. But from where I sit these are a few of our more pressing needs. To begin, we must have better air-ground control communications. Our helicopters and support aircraft must be able to be contacted at low level at greater distances. We need positive control. Airborne sin-

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Sixth Fleet Communicates

(*Continued from page 37*)

quired to shift from peacetime procedures to an emergency or war status. As expected, this has paid off every time during recent emergencies.

The most recent and dramatic use of Sixth Fleet power was in the 1958 Lebanon crisis, when effective communications helped get forces on the scene in time to prevent a major outbreak of trouble.

Many Fleet ships were in various ports late on July 14, when word was sent from Washington for the Sixth Fleet to provide assistance in Lebanon.

Within 15 hours, Marines from the Sixth Fleet had landed in Lebanon, covered by fighter and attack planes from Sixth Fleet carriers maneuvering off shore. This force was at full strength within 72 hours.

Nor is the value of Sixth Fleet communications apparent only in military situations. For example, a radio message from a fleet destroyer gave the Greek government the first word of an earthquake that brought disaster to the community of Volos. Sixth Fleet units were among the first outside activities to learn of the December flood disaster at Frejus, France. They responded instantly by sending a doctor, a helicopter and crew, medical supplies and food.

Some peacetime episodes have seriously tested the flexibility of the Sixth Fleet communications system.

Just recently when the President of the United States came on board *Des Moines* at Athens, the flagship was exercising over-all control of a joint U. S.-French anti-submarine and anti-air warfare and of an amphibious landing operation at Anzio. Naturally, the President's arrival placed still greater requirements on our communications. Some of the needs of the Chief Executive could be met by merely increasing the traffic carried by our usual radio channels. In other cases, we set up special circuits.

Between December 15 when he came on board and December 18 when he left at Toulon we handled numerous personal messages from the President to the White House and daily press conferences between Mr. Hagerty on the *Des Moines* and about 80 newsmen on the *USS Essex* which was in company with the *Des Moines*. In addition, we relayed about 100,000 words of press copy and more than three hours of broadcast time originating from civilian radio and TV commentators aboard the *Essex*.

The success of this operation—and an indication of the effectiveness of the Sixth Fleet communications—is reflected in the following message sent to me, and the commanding officers of the *Des Moines* and the *Essex*.

"From Jim Hagerty, Press Secretary to the President—I particularly know of the problems that have confronted all of you in handling the communications of the White House and the press of the world during the President's visit with you. It hasn't been an easy job and it's been one that has kept you working around the clock. But the results have been magnificent. Through your efforts, the news of the President has been reported throughout the world.

"The President's own communications have been fine at all times. And so—to all officers and men—my personal as well as official thanks. It was the best job I have ever seen. I have personally told the President of this and I am speaking in his name when I send all of you this message, 'Thanks for a tough job well done'."

As in so many other phases of Sixth Fleet activity good, reliable communications depend on headwork, hard work and teamwork.

Amphibious Assault

(*Continued from page 62*)

gle sideband may provide the answer or perhaps a type of communication operational satellite to relay line-of-sight control in place of our limited airborne relay techniques.

The coming tactical and logistical data systems should be of tremendous value to the complex amphibious assault. There exists a real problem for rapid collection, reduction, evaluation and display of information related to decision making. We are way behind in properly evaluating and displaying the present flood of tactical and intelligence information flowing into the command flag ship.

Our crypto devices are rapidly improving. Our command circuits now have automatic crypto service. However, we must have our teletypes operating at page speed rather than line speed. Speech ciphony is vitally necessary. With the speed of tomorrow's aircraft at hand, the need to verify a suspected false transmission may be catastrophic.

We should increase military use of television both externally and for internal closed circuits. Two years ago during an exercise off the North Carolina coast, bad weather obscured a view of the landing beach from the flagship. A commercial TV station crew providing local coverage gave TV viewers aboard ships some real close-ups. This technique would be extremely valuable in an amphibious assault.

With regard to our more unsophisticated equipment, such as boat and vehicular radios, construction should be such that any personnel using this equipment can maintain it by replacing readily identifiable parts — just like changing a light bulb or flashlight battery. This would relieve our sorely needed electronic technicians for the more complicated equipments. Furthermore, today's military electronic equipment has a lifetime measured in hours. We need substantially greater lifetime, thus providing savings in money, valuable space, increased reliability, to say nothing of a tremendous reduction in personnel maintenance.

I realize all of the above and much greater improvements are only a question of time, money and the imagination of American industry. All this I am sure is forthcoming. We are on the threshold of a tremendous electronics era. The Amphibious Force is ready now—and will be in the future—with better communications for command control.

Shipboard Antenna Systems

(*Continued from page 59*)

cations special antennas are designed. On existing ships a dual frequency range broadband discone/cage antenna may be installed in front of the guns near the bow, or at the stern. This antenna can accommodate a large number of multicoupled transmitters. It consists of two broadband radiators combined into one physical structure. Improvements realized by use of these installations have more than compensated for the small restriction in arc of gunfire caused by the antenna location.

Future ships of the Fleet are being designed to provide optimum antenna system performance. Electronic Architecture concepts are applied in the preliminary design stages of planning. Model studies are made to permit the parallel and coordinated design of antennas and ship's structure. Changes can be made to masts, stacks and structure, at no cost, before construction is initiated. These ships will have the most efficient antenna systems that can be installed on a Navy ship within the state of the art as we now know it. We continually seek new techniques and developments which will further enhance performance in this unique field of Man O' War antenna design.

PACIFIC MISSILE RANGE recovery operations

by J. M. WRIGHT, HEADQUARTERS, PACIFIC MISSILE RANGE

During a typical Discoverer operation a 300-plus pound re-entry capsule, ejected from an earth-circling satellite, becomes the focal point of a concentrated tracking and communication network dedicated to recovering a man-made object from outer space.

Before the instrumented satellite is hurled into a polar orbit, Pacific Missile Range (PMR) ships are deployed and U. S. Air Force recovery aircraft and PMR frequency interference monitoring planes and recovery helicopters are readied for the crucial capsule recovery phase.

Normally, re-entry of the orbiting satellite begins between Alaska and Hawaii in the vehicle's seventeenth pass around the earth, when a timing device triggers events leading to separation. Immediately thereafter, retro-rockets slow the ejected capsule for re-entry into the atmosphere. Then, a parachute lowers the package to earth.

Air Force C-119's, vectored into position by radar-equipped RC-121's, attempt to catch the descending parachute. Should this attempt prove unsuccessful, two specially-equipped Pacific Missile Range recovery ships and their supporting helicopters are on station to provide additional assistance during retrieving operations.

Over-all recovery operations are directed by the Air Force from the Hawaiian Control Center (HCC) at Hickman AFB. A direct telephone line links a PMR officer at HCC with the headquarters of the PMR representative at Kaneohe Bay Marine Corps Air Station, the control center and communication terminal for Navy forces involved in the operation.

Traffic between the PMR representative at Kaneohe center, the Naval Missile Facility at Point Arguello, and the PMR Headquarters at Point Mugu is carried on a full period teletypewriter circuit. The latter is supplemented by a private line telephone circuit during periods of actual recovery operation. These two circuits are part of a considerable communication network tying together the various operating points of the PMR at locations such as South Point and Barking Sands in the Hawaiian Islands and the island of Wake. Broadly, this communication network carries data involving Range Safety, a Missile Impact Location System, and other range instrumentation functions. In this typical Discoverer recovery operation, another principal purpose is to pass current and last minute operating instructions to the PMR recovery units.

The PMR operations and communication control center at Kaneohe Bay contains the terminals of an extensive but simplified radio communication facility with substantial coverage in the HF, VHF and UHF spectrum. The available operating modes are voice, teletypewriter and continuous wave (CW). These circuits link the range instrumentation ships, recovery ships, and frequency interference monitoring aircraft into a single control point which can immediately accept and transmit the recovery commander's directions as they are passed over the direct telephone line from the Hawaiian Control Center.

A voice circuit on high frequency single sideband (HF SSB) is the normal command and execute channel, with radio teletypewriter for passing detailed operational information and data in any required volume. A CW circuit is constantly manned and checked as an over-all back-up in case of low intelligibility or failure on the primary circuits.

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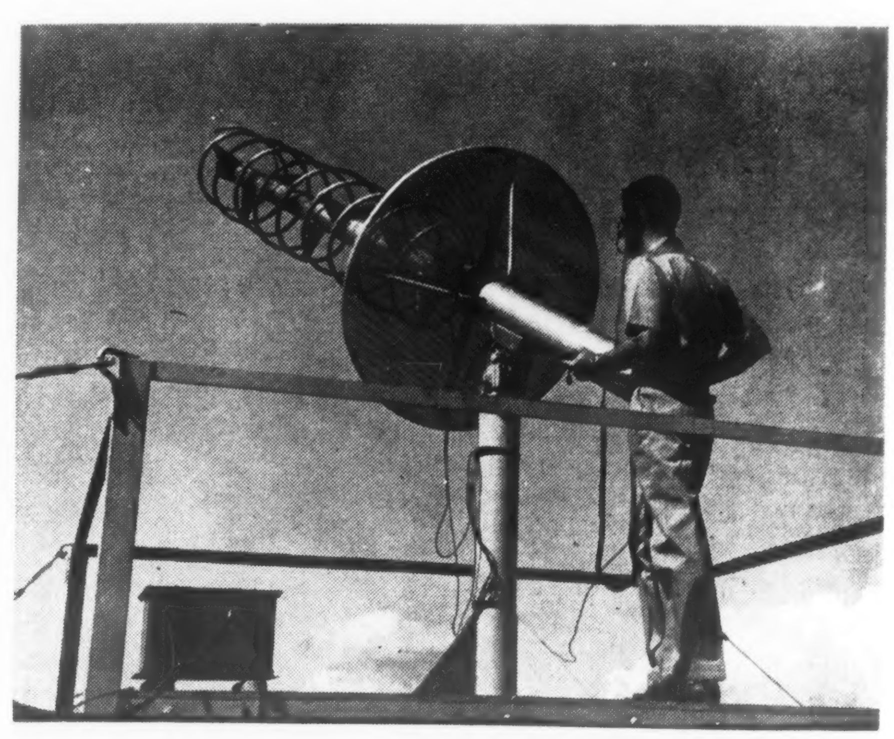
Mr. L. O. Robinson, Bendix Radio Corp. technician on board the Pacific Missile Range surface recovery ship* USNS Haiti Victory*, tunes a receiver in the teletype circuit linking the recovery ship with the Pacific Missile Range communication-control center at the Kaneohe Bay Marine Corps Air Station on Oahu. One Model RBB receiver (left) and one Model RBC feed through a Model AN/URA-8B converter (lower center), constituting the shipboard terminal of a typical MHF-HF TTY circuit.



Communication equipment operator mans the manually-trained, nine-turn Helix TM receiving antenna mounted on the forward cargo hatch of the Pacific Missile Range surface recovery ship* USNS Haiti Victory*. A remote signal strength indicator (left) is mounted on the base of the antenna to assist the operator in tracking the Discoverer satellite. Sound-powered headset is used for communication between the top-side operator and the TM recorder operator below. The Helix antenna is part of the Nems-Clarke "hip-pocket" telemetry tracking station installed on each of the surface recovery ships.

Pacific Missile Range

(*Continued from page 64*)

The voice circuits are HF SSB (suppressed carrier) utilizing Collins KWT-6-5 transmitter-receivers and antenna tuners. The HF ship to shore RATT and CW circuits employ Navy TBK transmitters and RBB or RBC receivers with frequency shift keyers and adapters. Circuit control is effected from the PMR representative at the Kaneohe control center, but the actual transmitter installations are at the Naval Communication Station (Transmitting) at Lualualei, a component of the Naval Communication Station, Pearl Harbor.

At a predetermined point in the count-down of an operation, all radio circuits and the leased teletype and telephone to the mainland are reserved for recovery operation traffic only.

Surface Recovery Ships

The two surface recovery ships, *USNS Haiti Victory* and *USNS Dalton Victory* are VC-2 victory class cargo ships that have been converted, with Advanced Research Projects Agency funds, for their specialized satellite recovery roles. Both are operated by the Military Sea Transportation Service under technical control of a PMR officer. Bendix Radio Division (Bendix Aviation Corp.) personnel, under contract to PMR, operate and maintain communications, radar and beacon direction finder equipment installed in these ships.

The principal modifications made to ready these ships for their Discoverer capsule recovery missions included the installation of an AN/SPS-29 air search radar, a modified AN/FLR-2 pan-scope beacon direction finder and communications equipment for operation in the HF, UHF and VHF portions of the radio spectrum.

Each ship is also equipped with a telemetry tracking station for tape recordings only. The equipment consists of two Nems-Clarke Type 1502 TM receivers and an Ampex type 960 two-channel magnetic tape recorder coupled with a nine-turn, manually-trained, helix antenna mounted atop the forward cargo hatch on the main deck. A Nems-Clarke type 1403 TM receiver tied to a one-channel Esterline Angus chart recorder records signal strength and a Hammarland SP600 receiver injects WWVH timing signals.

The top-side antenna operator trains the helix by signal volume and signal strength shown on a meter mounted at the base of the antenna. Recordings of the TM signal are reduced for post-operation evaluation.

Additionally the *Haiti Victory* carries aerological equipment consisting of two radiosonde receivers (AN/SMQ-1) with associated communications receivers (one Model RBC, one Model RBA and one Model RBB); a facsimile recorder (Model RD-92/UX) and two teletypewriters.

For physical recovery of a capsule, each ship carries two HRS-3 helicopters, flown by Navy personnel; two Navy frogmen and an LCPL recovery boat. Ship modification included installation of a helicopter landing platform on the after deck plus construction of a hangar large enough to accommodate both helicopters.

Range Instrumentation Ship

The Range Instrumentation Ship, *USNS Joe E. Mann*, is also a VC-2 operated by the Military Sea Transportation Service under technical control of a PMR officer. It participates in the capsule re-entry phase of the Discoverer operation from a position midway between Alaska and Hawaii. Telemetry tapes, recorded during the separation and re-entry phase from a Nems-Clarke AM/FM receiver coupled to a tri-helical antenna installation, are used for post-operation evaluation. These tapes are flown from the ship to Hawaii by using a unique sea-anchor, boom-rigged tape pickup. The tape containers are attached to a cable stretched between a trailing sea anchor and a boom on the stern of the ship. An Air Force C-119, flying at wave-top altitude, hooks the cable which breaks away at each end. The tapes are then reeled into the plane and flown to Hawaii.

Air-to-surface VHF and UHF circuits linking the vectoring aircraft, frequency interference monitoring aircraft and the recovery ships are used in conducting on-the-scene surface recovery operations. For UHF communications each recovery ship is equipped with two AN/GRC-27, 100-watt transceivers and associated equipment coupled to AS/390 SRC mast-mounted antennas. VHF communications are conducted over 30-watt AN/URT-7 transmitters and AN/URR-27 receivers.

UHF and VHF circuits are also employed between each ship's recovery information center and its respective helicopter, after the helicopters are launched to conduct a surface search for the floating capsule. Homing equipment, an AN/ARA-25 direction finder, tuned to the capsule beacon frequency assists the helicopters in locating the package.

Telemetering

(*Continued from page 57*)

animals are to be studied, they must be evaluated when the animal is away from physical contact or the presence of humans. This, of course, is quite possible through the art of radio telemetering. In studying the behavioral patterns of small animals, a great deal of information can be acquired through attaching a constant signal source to small wild life and following their movements through continuous triangulation on the signal. This system provides a means of tracking the animals at all times, both night and day and when they are underground. The only restriction on telemetered tracking of wild life at present is the limitations imposed by the mass of the power source and antenna which the animal must carry. Experimental work is now underway to utilize the temperature variants or potential differences within the animal, itself, as a possible power source to energize the transmitter. This will immeasurably increase the time increment and extend the application to smaller animals. For shorter range work, simple tank circuits with or without a self-contained power supply can be used. Several such units have been designed for measuring fluid pressures, temperature and acid-base relationships of the intestinal tracts of small animals (Fig. 1). Such systems

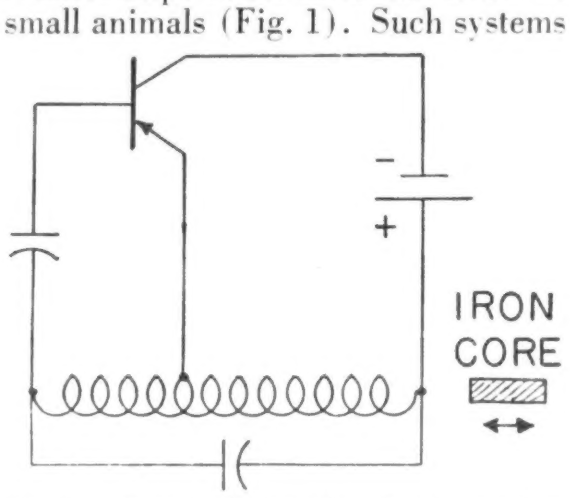


Fig. 1.—Circuit of a swallowable transmitter for measuring temperature and pressure. The transistor acts as a thermometer and pressure modulation is provided by motion of the iron core in or near coil.

emit signals whose frequency is directly related to the changes in the particular phenomena studied. This technique was utilized by the American Electric Laboratories in building the "Penguin Egg," a temperature telemetering device designed specifically for obtaining data on the incubation temperature of Antarctic birds. C. Ecklund and F. Charlton successfully used this device during the 1957-58 IGY, at which time they instrumented and studied the Adélie Penguin and South Polar Skua eggs. Human studies were also done at that time with a similar transmitter for

the observation of human body temperature changes relative to the effectiveness of experimental exposure suits. This work was done by Charles Schwarz of the Navy Clothing Supply Depot. The range of the instrument used was about 50 feet and both transmitting and receiving loops had to be oriented properly for functional efficiency. Longer range transmissions have been accomplished in monitoring experimental animals in rocket flights. The information telemetered has been that of the simpler subjective changes involving blood pressures, pulse and respiration rates, temperature changes and some of the easier measured chemical changes of the body. In some of the more sophisticated experiments, blood changes were measured by direct canulization of blood vessels with transducer tipped catheters.

An intense interest exists in the medical fraternity in the consideration of clinical medical aspects of telemetering. Electrocardiograms have been telemetered and diagnosed correctly over long distances and from an aircraft in flight. The latter feat was accomplished by Dr. Barr and associates from the Naval Medical Research Institute in 1958. This same group was able to pick up telemetered data in a Navy flying laboratory from an instrumented monkey in the nose cone of a rocket the following year. Telemetering of electroencephalograms has also been accomplished. It is interesting to note that this procedure was successfully reversed in experiments predating the radio telemetering of electrocardiograms. The transmission of stimuli to implanted electrodes in monkey brain which elicited predetermined responses in behavior was done some time ago. Behavioral changes, such as food- and water-intake of laboratory animals, had been varied by this experimental process. The possibility, undoubtedly, exists of complete working control of an animal by combining central nervous system input and output through the medium of stimuli control by a transceiver system.

In the manned balloon ascensions accomplished by the Office of Naval Research in its project "Strato Lab," the pilots and occupants have been monitored by psychological telemetering to an airplane in flight. This airplane is completely equipped for telemetering and is manned by personnel from the Naval Medical Research Institute and the Office of Naval Research. The work in the study of telemetering began at NMRI in 1947 and was later expanded to include the above-mentioned flying laboratory known as project RAM (Research Aviation Medicine). The RAM aircraft and its job of monitoring the ONR's high altitude balloon flights was an excellent experimental test bed for radio telemetering and, as developments in the electronic field occurred, continuous improvements were made. By 1953, the packaging of the basic equipment for physiological telemetering of data from an aviator in a single engine plane was accomplished. This included the electrocardiogram, electro-encephalogram, respiratory rate and volume, and skin and body temperatures. By 1954, the range of reception was consistently good at 80 miles. In 1957, with the introduction of transistors, the then existing equipment was modified accordingly. Radio telemetered physiological data have been received by the RAM aircraft and then relayed over 6,000 miles of telephone circuit with sufficient clarity for clinical diagnosis. The NMRI-ONR group has also demonstrated the feasibility of television reception and transmission of physiological data. The physiological data which can be telemetered now consist of (a) electrocardiogram, (b) body temperature, (c) respiration rate and volume, (d) galvanic skin response, and (e) electro-encephalogram. Efforts are being made to augment these equipments by developing the means of telemetering additional data on blood oxygen content and other chemical changes in the blood, urine changes, and endocrine functions.

In view of potential manned space flight, the perfection of the telemetering of medical information takes on an added significance. In addition to the perfection of present methods, the versatility of the equipment will be greatly improved to include many physiological manifestations not now available for telemetering due to inadequate pickups. Additionally, means of carefully monitoring the ambient physical environment in conjunction with physiological changes must be made available for the total evaluation of the conditions to which the astronaut is exposed.

In retrospect, it may be confidently stated that the field of telemetering medical information has a greater utility than commonly supposed. It might also be stated that the potential utility of this type of radio communication is becoming clearer, and definite programs for the exploitation of the science are being vigorously pursued.

TELEMETERING PSYCHOLOGICAL DATA BY LCDR. D. D. SMITH, USN, NAVY MEDICAL RESEARCH INSTITUTE

Several interesting experiments in the telemetering of physiological data have been accomplished through use of the facilities of the Pentagon Terminal of the Navy High Command Voice Single Sideband Network. In May 1959 a phone patch linked this network to a laboratory at the National Naval Medical Center, Bethesda, Maryland. Two way transmissions of both physiological data and voice were carried out with the *USS Franklin D. Roosevelt* in the Mediterranean off the coast of Greece. This in effect enabled the cardiologists in Bethesda to view directly the tracings of the electro-cardiograms as they were administered aboard the carrier several thousand miles distant. These specialists then diagnosed the conditions of ambulatory patients borrowed from a hospital in Athens and transmitted their recommendations for treatment immediately to the carrier as though the patient were just next door. Crown Prince Constantine of Greece was an admiring spectator on the carrier for this demonstration.

A similar arrangement had previously been effected for the 11th meeting of the Academy of General Practitioners in the Civic Auditorium in San Francisco, California. On this occasion the information was transmitted non-stop to the Naval Communications Station, San Francisco, thence by telephone to the Aviation Physiology Laboratory at the U. S. Naval Air Station, Alameda California. Here the information was demodulated and displayed before colored television cameras which in turn transmitted the data to a huge screen in the civic auditorium. Both audio and physiological transmissions from Bethesda to the auditorium in San Francisco were completely satisfactory during the testing of the system. However, a period of exceptionally strong solar prominences precluded acceptable monitoring of the data during the scheduled presentation at the meeting.

Other programs are under way which will link the very latest techniques of carrier wave transmission with the newest developments in medical research.

by LCDR JOHN L. KENT, USN
ELECTRONIC WARFARE BRANCH
OFFICE OF THE CHIEF OF NAVAL OPERATIONS

NAVAL ELECTRONIC WARFARE ■■■■■■

ECM/ECCM

FROM THE CAVE-MAN'S club to Nikita's missiles, every weapon has produced a counter-weapon. The fate of battles and sometimes wars has turned on the rapid application of an effective countermeasure. The evolution of electronic countermeasures was thus a natural reaction when man called upon the electron to help direct his weapons.

Today, electronic warfare embraces not only the military use of electronics to reduce the effectiveness of the enemy's weapons employing or affected by electromagnetic radiations, but also involves measures to insure the effectiveness of our electronic weapons.

Electronic countermeasures (ECM) encompass those measures to degrade the effectiveness of the enemy's weapons employing electronics and include four major categories: Radar countermeasures, communications countermeasures, navigational aids countermeasures and controlled devices countermeasures. All countermeasures activity falls into either one of two classes—passive ECM and active ECM. Passive ECM involves all countermeasures not detectable by the enemy such as searching for, receiving and analyzing enemy signals. Active ECM is detectable by the enemy; jamming enemy communications and radar signals or the use of foil strip known as "chaff" to create false targets on an enemy radar are examples.

Electronic counter-countermeasures (ECCM) involve those measures taken to insure the effectiveness of our own weapons. ECCM at its simplest might involve the shifting of a radar frequency away from the frequency of an enemy jamming signal, for example. The use of devices such as heterodyne filters and speech clippers are useful ECCM devices for countering communications jamming; numerous other engineering methods are employed to counter enemy efforts at jamming our radar, missile guidance systems, navigation systems, etc.

The United States Navy has a long history in the countermeasures field and is active in all phases of electronic warfare, both shipborne and airborne. Modern naval strategy depends vitally upon the effective use of military electronics. The Navy employs electronic countermeasures to help maintain the effectiveness of its own electronic weapons and to allow the enemy minimum possible advantage from his use of electronics.

Radar Countermeasures

Radar has perhaps changed the tactics of modern warfare more than any other single development. The Germans, beginning in the early days of World War II, utilized this new capability to "see" and attack an enemy hidden by smoke, fog or darkness. When the United States entered the war the Third Reich was ringed by thousands of radar sites. Radar was airborne to help German fighters find our aircraft at night; it was seaborne to help locate and sink our shipping. Although German radar research had an early start, they fortunately made a vital strategic error. In anticipation of a short war, the Germans early standardized on only a few models. This action paved the way for the rapid application of effective countermeasures. The success of that countermeasures program and the extent of its vital contribution to eventual victory both in Europe and in the Pacific is probably one of the least appreciated and most unpublicized facets of World War II. Suffice it to say here, however, had effective radar countermeasures not been developed and employed quickly, the course of the war could have been tragically changed.

Countermeasures to combat other important electronic weapons systems were developed and used which also contributed heavily toward our eventual victory in both Europe and the Pacific. The anti-radar program was, however, conducted on a far more extensive scale.

The radar countermeasures development program was a cooperative effort involving many agencies. Within the Navy Department, the Naval Research Laboratory, the Bureau of Ships and the Bureau of Aeronautics were prominent in the early work. The Navy employed a wide range of countermeasures equipment during the war and since has continued a steadily increasing interest and participation in the countermeasures program.

The course of electronic warfare is guided to some extent by enemy electronic activity. In recent years our potential enemies have developed and are employing a vast array of electronic weapons. World War II ECM effort was largely a series of reactions to shifting enemy threats. Doubtless this will continue at least in some degree. The Navy has an established Quick Reaction Capability which permits the rapid application of required countermeasures to meet a specific threat. However, we can no longer afford to wait, assess the threat and then react as formerly. Modern naval strategy in a nuclear environment demands that we have the basic ECM tools not on the drawing board or on the shelf, but in our ships and aircraft with crews thoroughly knowledgeable in their use.

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Electronic Warfare

(Continued from page 69)

Electronic warfare must maintain a status similar to that of radar, sonar, missiles and other major electronic systems. Adequate numbers of countermeasures systems must be procured and installed which permit a continuing program designed to be sufficiently flexible to meet a variety of enemy threats with an assortment of countermeasures. A high level of development effort must also be maintained. It must be guided by accurate intelligence about new enemy electronic developments so that ECM can meet and, if possible, anticipate the changing threat.

Although the Navy has several agencies of its own continuously and effectively engaged in countermeasures research and development, the task is a challenging one requiring an enormous effort. Civilian laboratories also aid the Navy in its ECM effort, but more help is needed. It would appear that the electronics industry may not have attacked some of the thorny problems connected with countermeasures with quite the same enthusiasm shown other military electronic research problems whose solution might have wider application. In our economic system this is understandable, but notwithstanding, some strong research shoulders against the wheel are needed if we are to come up with the answers we must have.

A factual assessment of capabilities of other nations in the countermeasures field is a highly sensitive subject obviously beyond the scope of this article, but there are adequate unclassified sources which demonstrate the considerable Soviet attainments in general electronics. In the active countermeasures field, Soviet jamming efforts are notable and provide the most obvious example of Electronic Warfare and its current application in tactics of the Cold War. In peacetime the Soviet effort to jam our information programs involves the Navy only indirectly, but this situation could change suddenly and drastically. For this reason, Soviet jamming activity involves much more than just a serious annoyance factor to our Voice of America.

In order to assess this potential threat to our Naval and military communications, let us examine this overt example of Soviet electronic warfare in some detail. In jamming, transmission of an interfering signal is made on the frequency of the signal it is wished to combat. Communications jamming is a type of radio interference planned to totally deny the receiving of a message or program and so annoy the listener that military men will tend to give up attempts to receive the transmission while civilians looking for entertainment will simply turn off their sets. Jamming may take many forms, like superimposing other program material such as music over speech, transmitting unintelligible noise, buzz-saw or bagpipe discord, or more usually the transmission of "white noise," i.e., noise covering the entire range of the audio spectrum.

The Soviets began jamming operations in February 1948 for the purpose of interfering with Russian-language programs originating in the United States; later they started to jam the British Broadcasting Corporation. At first, the jamming efforts were only nominal but as the Cold War wore on jamming became a principal weapon. By April 1949, the full force of the Soviet jamming network was apparent. The United States protested to Moscow about jamming the Voice of America (VOA) broadcasts, but the Soviet Minister of Foreign Affairs replied that no Soviet transmitters were using the VOA frequencies. A series of protests and charges were presented before several international bodies including the General Assembly of the United Nations but the Soviets turned the large deaf ear and charged that the U. S. and Great Britain through the VOA and the BBC were engaged in psychological warfare and that Moscow has, "the right and the duty . . . to paralyze the aggressor in this radio war." The jamming continued.

The day Mr. Khrushchev arrived in the U. S., 15 September 1959, the Soviets took their jammers off the air for the first time since April 1949, when jamming started in full force. Since Mr. Khrushchev returned home, the jamming has been resumed, but in a more selective manner, permitting some VOA broadcasts to proceed unjammed. This may foreshadow a new tack in this phase of the Cold War, since the Soviets recently agreed to cease jamming broadcasts of the British Broadcasting Corporation.

Voice of America broadcasts to Communist China are also jammed. The Chinese jammers started in September 1958 and have continued since that time.

Voice of America broadcasts to Europe normally originate in Washington and are relayed and retransmitted from high powered transmitters at places like Munich, Germany; Salonika, Greece; or Tangier, Morocco. Programs are in many languages and transmissions are made on about 16 different frequencies including both broadcast band frequencies and short wave. Some 85 transmitters are used by the VOA in an attempt to blanket the Soviet and her satellites.

Because of the wide frequency diversity used by the VOA and the high transmitter powers employed, jamming "the voice" effectively is an enormous undertaking. The Soviets currently are employing more than 1500 transmitters at 300 sites in the USSR and an additional 750 transmitters at about 90 locations in Czechoslovakia, Hungary, Rumania and Bulgaria. This installation of jammers cost an estimated $250 million and requires an annual operating expenditure of about $185 million. Our VOA efforts are only a small fraction of that amount.

The Soviets employ transmitters developed by their engineers especially for jamming operations. These transmitters are capable of rapidly shifting frequency and produce effective noise modulation at power levels up to 1,000,000 watts.

The effectiveness of the Russian efforts to blot out the VOA varies considerably with the area involved and depends upon the number of frequencies employed by VOA. Although jamming is a major problem it is most effective only around the larger cities where jammers are concentrated. Many VOA broadcasts in Russian and other languages do get through. Escapees from the Iron Curtain are the best evidence of how well the programs are heard.

The jamming problem has no single "magical" solution. Measures that are effective today may be unacceptable tomorrow because of increased jamming power. The VOA recognized early that jamming could be countered only by an aggressive versatile approach including a wide range of latitude in engineering, operating and program techniques.

Soviet Potential

Conversion of the tremendous Soviet jamming potential to military advantage in a wartime situation could hardly be unexpected. The engineering experience, the reservoir of trained operating personnel and the vast network of operating transmitters comprise a truly formidable electronic threat. That Soviet countermeasures accomplishments have been confined solely to the communication field would be a supposition at the extreme of naïveté. We are bound to credit the Soviets with proficiency in countermeasures at least on a par with some of their demonstrated cap-

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UNTIL THE BEGINNING of World War II, the Navy's point-to-point communications system was entirely dependent upon continuous wave (CW) radio telegraphy as the method of transmitting all message traffic. As the war approached, the pressure for increased traffic capacity and speed led to the use successively of high speed Boehme CW, single channel frequency shift keying (FSK) teletype, 4 channel mechanically multiplexed FSK teletype, and finally at the end of the war, to an independent sideband system that afforded 6 teleprinter channels on one sideband and a voice channel on the other sideband. More recently the 6 channel, frequency diversity, paired tone teleprinter terminal equipment that was installed as part of the initial SSB system has been replaced with a 16 tone, narrow band FSK teleprinter terminal equipment that employs space diversity reception instead of frequency diversity and thus makes possible 16 teleprinter channels. This 16 channel AN/FGC-29 system is currently standard equipment on all trunk single sideband point-to-point circuits. Since there is a steady increase in the point-to-point traffic load and an ever increasing demand for more rapid handling of peak load traffic, there has been a great deal of interest developing in more sophisticated terminal equipments, such as the 40 channel phase shift terminal, that are capable of further increasing the capacity of existing communication channel assignments. There is also a rising demand that outage time from all causes on the point-to-point circuits be reduced to an absolute minimum.

The single sideband transmitters and receivers employed on the Navy's point-to-point circuits are primarily standard commercial communication equipment, the basic designs for which were developed in the early 1930's for use on commercial transoceanic telephone and teleprinter circuits. Even though there have been many improvements in components used in the newer transmitters and receivers, the fundamental principles employed have remained substantially unchanged. One of the basic problems of single sideband systems is the generation of an accurate carrier frequency in the SSB receiver with which to demodulate the received sideband signals. The more accurate and stable the reconstituted carrier, the higher the quality of the reproduced signal. In actual figures, the reconstructed carrier must be within 15 cycles of the transmitter carrier for good quality voice reproduction, within 5 cycles for peak performance of frequency shift tone teletypewriter systems, and within one cycle for the highly sophisticated multitone systems. To achieve accuracies of this order in the frequency range of 4 to 24 megacycles, the original SSB systems employed receivers designed to accurately follow and reconstitute a partially suppressed transmitted carrier. The systems in use at the present time still employ carrier following receivers to achieve an accurate demodulation carrier.

In the early 1950's, the Naval Research Laboratory, BuShips, and CNO embarked on a joint investigation into the possibility of employing SSB techniques to increase communication capacity and reliability in ship-to-ship and other general communications applications. It was immediately apparent that carrier-following SSB equipment would be useless for applications that required

frequency stabilization of point-to-point SSB circuits advantageous

by Bert Fisk and C. L. Spencer, U. S. Naval Research Laboratory

netting and short intermittent transmissions; therefore, the SSB equipment developed for the new highly diversified applications was premised on the use of transmitters and receivers and inherent frequency accuracies and stabilities better than one part in 10^7 per day. Equipment of this type is currently being delivered to the Fleet and is proving its value under actual operating conditions. A further project that developed out of this SSB development program was one that proposed an investigation into the values of full frequency stabilization of point-to-point circuits. The Naval Research Laboratory has for many years been advocating higher orders of frequency accuracy in radio communication services and has been developing precision frequency generating and synthesizing systems which can provide the degree of accuracy, flexibility, and stability required for SSB operation. It has been only recently that adequate frequency synthesizers have become available to make it possible for the Navy to carry out this investigation.

In the meantime, the interest in sophisticated tone terminal equipment had increased to a point such that the Army Signal Corps conducted tests of a phase shift tone terminal system over their conventional AFC independent sideband system between the East Coast and the Hawaiian Islands. These tests were disappointing in that they indicated that this particular multiplexing technique would not function satisfactorily on such a circuit. Shortly after the completion of the Army tests, the Navy conducted similar tests of a phase shift system on the Navy's conventional AFC sideband circuit between Washington, D. C., and North Africa. The results obtained were equally as disappointing as those obtained by the Army. It was at this point that the Naval Research Laboratory came into the picture to make a study and evaluation of the situation. As far as could be determined by NRL, the difficulties that had been encountered were not caused by any inherent deficiency of the phase shift principle but rather resulted from the inability of the conventional AFC sideband system to handle adequately a phase shifted type of signal. Therefore, it was agreed by all parties concerned to continue the tests subsequent to the installation of a 500 watt frequency stabilized shipboard type transmitter at the North African end of the circuit and the installation of a frequency stabilized dual space diversity receiver at the Washington end. When the evaluation was continued employing the frequency stabilized transmitter and receiver, it was found that even though there was a very remarkable improvement in the performance of the phase shift system, the error rate was considerably higher than that for the AN/FGC-29 with which it was being compared. Further study of the problem brought to light the fact that a high percentage of the "hits" were occurring simultaneously on all channels. Since this is not the manner in which "hits" usually occur on a long range circuit, equipment deficiencies were indicated. When this problem was finally resolved it was found that power line surges were causing both the stabilized frequency transmitter and receiver to introduce sudden, radical phase changes in the signal to the receive phase shift terminal. The difficulty was eliminated by the installation of regulated power

supplies in both the transmitter and receiver. After this problem was cleared, the error rate of the 40 channel phase shift system was on a par with that of the AN/FGC-29 when both were operating simultaneously over the same stabilized circuit, one system on the upper sideband, the other on the lower sideband.

Doppler Frequency Shifts

Several interesting observations were made during this evaluation that have a direct bearing upon future planning for point-to-point communications. First, the rate of phase change of long range HF signals was accurately measured and recorded over a considerable period of time and under a great many different transmitting conditions. It was found that at any time a circuit was sufficiently "good" to pass traffic by any of the means currently employed, the rate of phase shift was sufficiently small so that few if any errors would be caused from this source in a phase comparison system. Second, since the frequency standards at both ends of the circuit were maintained in relative frequency accuracy to better than one part in 10^8 it was possible to make rather accurate measurements of doppler frequency shifts of the transmitted signal. It was found that at any time a frequency was usable for handling traffic, the doppler shift was so small that it could not be measured. The greatest shift recorded was 2 cycles at 20 megacycles during a transition period when the signal was fading out. Third, it was found that when the AN/FGC-29 was employed with the stabilized 500 watt transmitter and stabilized receiver combination to handle the normal traffic load, circuits could be maintained longer and with fewer errors during transition periods or times of ionospheric disturbance than was possible with a 4 kw standard SSB transmitter and receiver combination. Several times it was found that when a particular frequency could no longer be used with the standard transmitter and receiver it was possible to change over to the low power stabilized system utilizing the same frequency channel and continue with acceptable copy all during the transition period.

This evaluation served to prove several important points such as the fact that multi-tone phase shift terminal equipment could be used successfully on long haul point-to-point circuits provided properly stabilized SSB equipment was used with it and the fact that a fully stabilized low power system could provide more reliable communications than a medium power conventional system. However, there were several important questions that remained unanswered, the most important of which was whether it would be possible to achieve comparable gains by properly stabilizing the SSB transmitters and receivers already in use by the Navy. To obtain answers to this question, the Navy established a second stabilization project, this one employing a fully duplex SSB circuit between Washington, D. C., and Hawaii. In this project standard LDT-2 transmitters and several types of receivers were frequency stabilized by means of several different types and configurations of frequency standards and frequency synthesizers. Also a brief test of phase shifted terminal equipment was carried out to further check the results obtained in the previous evaluation.

The second evaluation not only confirmed the general findings of the first Navy tests, but also brought out several additional significant points. First, it was determined that the LDT-2 type SSB transmitter can be satisfactorily and reliably stabilized by using the combined frequency standard and synthesizer which has recently been developed specifically for use with the LDT-2. When a reliable, low distortion, high power linear amplifier is added to a synthesizer equipped LDT-2 type transmitter the combination is an SSB transmitter that possesses all the features and capabilities necessary for state of the art communications. Second, several different receivers, including the FRR-10, were stabilized and tested on the circuit and all were found to perform satisfactorily. Third, the brief one-way phase shifted terminal tests conducted during this evaluation produced results that agreed closely with the findings of the previous tests, even though it was over a longer and more difficult circuit, namely, that when an SSB point-to-point circuit is adequately stabilized, the performance of the 40 channel phase shifted terminal is on a par with the 16 channel AN/FGC-29. Fourth, it was found that with frequency stabilized equipment, it was possible to successfully utilize frequency assignments that, because of persistent interfering signals in the area of the transmitted carrier, could not be used with the frequency following equipment. This was dramatically pointed up on the Washington-Hawaii leg of the circuit on which it had been impossible to use one of the choice frequency assign-

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SSB Circuits

(Continued from page 73)

ments because of persistent carrier interference. It was found that when the transmitter and receiver on the circuit were stabilized, this particular frequency assignment gave the best and most reliable copy of any assignment available in spite of the persistent interference.

In addition to the previously discussed advantages obtained through frequency stabilization of the point-to-point SSB circuits, there are several other significant advantages that were brought to the forefront during both series of tests. The ease and speed with which a frequency stabilized receiver could be set on frequency as compared to the tedious "fishing" procedure entailed in tuning the frequency following receivers was particularly impressive to all observing operating personnel. This speed of setting up a stabilized receiver was also found to substantially reduce the outage time when changing the operating frequency. One of the chronic problems encountered with frequency following receivers that is completely alleviated through frequency stabilization, one that plagues operators and causes innumerable outages, is that noise, interference, and/or deep fading of signals frequently cause frequency following receivers to "jump the track" and stay off frequency until manually retuned. Also as indicated previously, it was found possible to operate successfully with stabilized equipment during transition periods when selective fading was so severe that a frequency following receiver could not stay on frequency while, because of diversity reception, the teletype copy was adequate. On the Washington-Hawaii circuit, outages caused by interfering signals and transition periods normally account for a total of several hours' outage each day. The majority of this outage time was eliminated during the evaluation period when the circuit was frequency stabilized. A further interesting point is that it appears feasible to stabilize most of the more modern SSB point-to-point equipment at a cost that approximates $5,000 to $7,000 per transmitter or receiver.

As a result of these evaluations, the Navy is initiating immediate action to stabilize fully all of its point-to-point SSB circuits. The schedule to be followed will be to stabilize all the LDT-2 type transmitters now in use at the earliest possible date and then proceed with the stabilization of as many receivers as is practical and economical.

Electronic Warfare

(Continued from page 71)

abilities in other fields of technology such as missiles.

What can be done by the Navy and the other military services to combat the existing and supposed Soviet electronic threat? There are indeed scores of avenues for attacking this problem. Besides the more obvious answers involving vast procurement programs to match the Soviets, for instance in jamming power, watt for watt, there are other, at least partial solutions.

Some of these involve procedural methods involving no hardware. It has been said that the military services have become "communications happy," that we have come to depend more and more on electromagnetic radiations to guide our every move. This trend, at least, can hardly be refuted. Unless our dependence on electronics is to become a serious liability in wartime by revealing our presence to the enemy and providing him with a beacon to guide his missiles, we must learn to restrain our electromagnetic radiations to the absolute minimum. Turning any communications receiver across its designed spectrum leaves little doubt the "voices of Babel" are working overtime. Communications susceptibility to countermeasures can be decreased vastly by the use of good operating procedures, rigid limitation of traffic to only the vital transmissions, and development of good frequency diversity capabilities.

The electronics design engineer can do much to reduce the susceptibility of equipments and systems to countermeasures by proper design consideration and the incorporation of counter-countermeasures circuitry in all military electronics where feasible. In view of demonstrated Soviet ECM potential and their obvious inclination to employ countermeasures on a grand scale, our military electronics must be designed and conditioned to function effectively in a severe ECM environment.

Modern naval tactics demand a diversified suit of ECM equipments for naval ships and aircraft. Certain tactical considerations require naval task forces to operate in conditions of complete "electronic silence." These conditions require the utmost of passive ECM performance, tactics, and knowledge of enemy radiation characteristics. Other situations require active countermeasures including deception devices to confuse and decoy the enemy, devices to jam radars and other electronic equipment and devices capable of destroying the accuracy of enemy missiles and gunfire.

As more and more ECM equipments capable of fulfilling the above requirements are developed and installed in the ships and aircraft of the Fleet, the Navy is gaining a strong potential in Electronic Warfare. So long as the state of the electronics art continues to progress, new and improved countermeasures equipment will be required. The Navy has recognized this and has in being expanding programs both in ECM research and development and ECM equipment procurement.

In keeping with the increased importance of electronic warfare the Navy has established an organizational unit within the Office of the Chief of Naval Operations at the Division level, rather than at the Branch level as formerly. The new Electronic Warfare Division includes not only the Electronic Countermeasures Branch, but the Combat Directions Systems (Radar) Branch, and the Naval Tactical Data Systems Branch as well. Thus, a large segment of naval electronics will be coordinated under a single director. This organization will provide an improved status and increased recognition of the importance of electronics in modern naval strategy.

The 14th Annual Armed Forces Communications and Electronics Association Convention and Exhibit will be held at the Sheraton-Park Hotel, Washington, D. C., on Tuesday, Wednesday and Thursday, May 24, 25, 26, 1960.

THEME—*"Communications and Electronics—The Arm of Control, The Voice of Command."*

PANEL DISCUSSIONS—*Timely subjects accenting the Convention theme.*

May 24: *by National Aeronautics and Space Administration—"Electronics for Putting a Man into Space." Moderator—Herbert Rosen, NASA, introduced by John R. O'Brien, Hoffman Electronics, Washington AFCEA representive.*

1. *Communications and Location of Space Satellites—(speaker to be announced)*
2. *Utilization of Satellite Communications—Leonard Jaffee, NASA*
3. *Tracking Satellites—John Mengel, NASA*
4. *Communications at Lunar Planetary Distance—Robert Briskman, NASA*
5. *Advanced Technology for Space Communications—Jet Propulsion Labs. (speaker to be announced)*

May 25: *by Bell Telephone Laboratories, Inc.—"Space Communications." Moderator—Dr. J. R. Pierce, Bell Labs., introduced by Millard C. Richmond, Western Electric, Washington AFCEA representative.*

1. *Problems of Satellite Communications—Dr. J. R. Pierce, Bell Labs.*
2. *Bell Laboratories' Part in the Echo Experiment—W. J. Jakes, Bell Labs.*
3. *Active Satellite Repeaters—L. C. Tillotson, Bell Labs.*

WHAT AFCEA WILL OFFER




AT THE MAY CONVENTION

May 25: *"Scientific Applications (Communications and Electronics) of Photography." Moderator—RAdm Robert S. Quackenbush, USN (Ret.), introduced by RAdm. Dwight M. Agnew, USN (Ret.), Washington Associates, Washington AFCEA representative. (two speakers to be announced)*

May 26: *by General Electric Company—"Industry Reports." Moderator—Richard Shetler, GE, introduced by Thomas B. Jacocks, GE, Washington AFCEA representative.*

1. *Superconductivity—Lloyd Harriott, GE*
2. *Thermoplastic Recording—Dr. William Glenn, GE*
3. *New Horizons in Point-to-Point Communications—Allen Wild, GE*
4. *Systems Profile Analysis—Richard Shetler, GE*

KEYNOTE LUNCHEON—*May 24. Speaker—Admiral Arleigh Burke, USN, Chief of Naval Operations.*

RECEPTION-BUFFET—*May 24, with floor show, planned, arranged and produced by John Gilbarte, Admiral Corp.*

RECEPTION-BANQUET*—*May 25. Speaker—Leo Cherne, Executive Director, Research Institute of America.*

INDUSTRIAL LUNCHEON—*May 26. Speaker—Lieutenant General James D. O'Connell, USA (Ret.), Vice President, General Telephone & Electronics Corp.*

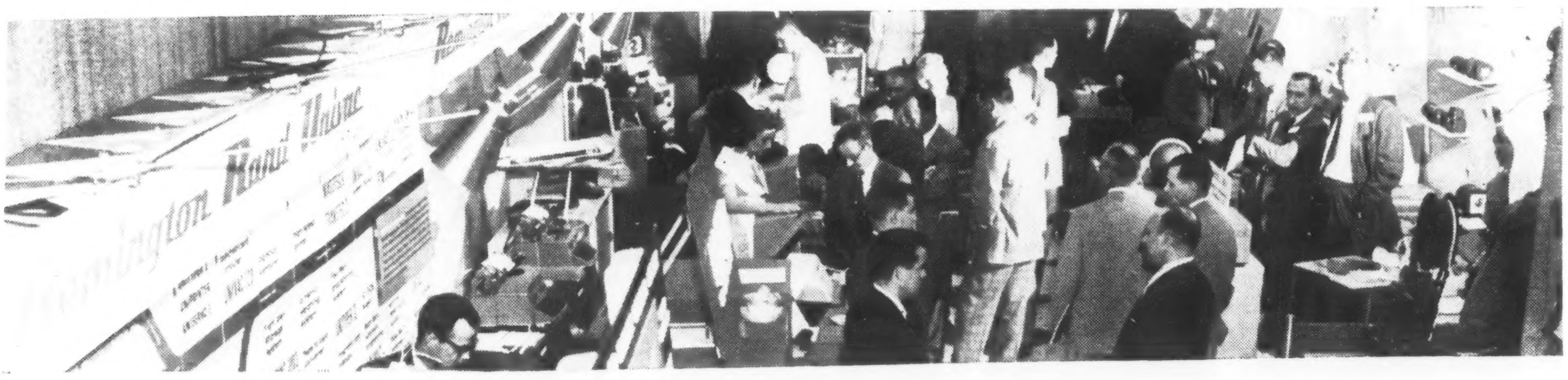
SPECIAL EXHIBIT—*Exhibits by the Army, Navy and Air Force will be part of the program for May 26, in honor of 100 years of U.S. Army Signal Corps Communications.*

CONVENTION EXHIBIT—*160 exhibits by industry showing the latest developments in communications, electronics and photography.*

TOUR—*May 25, to Naval Research Laboratory—Captains A. E. Krapf and D. G. Bryce.*

LADIES PROGRAM—*A special ladies program is being arranged by Mrs. Dorothy Christopher as chairman.*

**Friends and guests who are not seated promptly at 7:30 p.m. will be able to enter only after the introduction of head-table guests, presentation of the National Colors and the Star Spangled Banner and the Invocation. This action is based upon a majority request from the membership. In addition, tickets for the buffet, luncheons and banquet must be presented at the time of serving. Be sure to have your tickets with you.*



SERVICE TEST AND EVALUATION OF NAVAL COMMUNICATION EQUIPMENT

by LCDR. J. A. VAUGHAN, USN

Staff, Commander Operation Test and Evaluation Force

A LONG AND ESSENTIAL chain of events lies between the engineer in his laboratory developing a communication technique and the radio operator of a submarine using a piece of communication equipment below the Arctic icecap. One of the links of the chain is the highly essential Service Test and Evaluation. In order to gain service acceptance, new naval material must demonstrate its ability to function satisfactorily in the operational environment. The Chief of Naval Operations must determine before accepting an equipment for service use that it will improve Fleet capabilities. To provide the Chief of Naval Operations with the facts necessary to determine service acceptability, there exists an organization known as the Operational Test and Evaluation Force (formerly Operational Development Force). This Force operates to bridge the gap between the Developing Agency ashore and the fleet operator at sea.

The Operational Test and Evaluation Force stands as referee—without prejudice or bias—in the task of testing and evaluating naval material. The Navy must insure that it does not procure expensive, complex equipments which may be seriously deficient or unsuitable for service use. Such an action would be highly detrimental to the Fleet's operational readiness as well as to the Navy's pocketbook. On the other hand, there must be no atmosphere wherein the Developing Agency is reluctant to introduce equipment into the fleet until it is a finely polished "gem." This latter attitude can be equally harmful to Fleet readiness.

Recent changes in naval policy provide for Operational Test and Evaluation Force to participate earlier in the developmental stage of new equipment than was previously the case. It is not intended that this early participation will be that of a meddler, but rather as an interested ultimate consumer. The intent of this change is to reduce the time required to secure an operational evaluation and ultimate service acceptance of equipments by interjecting at an early date the comments of an unbiased organization which has the needs of the operating forces firmly in mind.

The composition of the Operational Test and Evaluation Force is designed to keep these manifold requirements of the Fleet constantly in mind. In addition to the Headquarters at Norfolk, Virginia, five Test and Evaluation Detachments and three Air Development Squadrons are in existence. The 20 ships and 42 aircraft assigned to these various activities, plus additional surface ships, submarines and aircraft provided by the two Fleet Commanders as required for various projects, comprise the forces needed to conduct comprehensive tests and evaluations of new equipments. The Force does not generate requirements for new or improved equipment. It does, however, report to the Chief of Naval Operations how well these equipments fulfill the requirements of the operating forces.

In order to see how the Chief of Naval Operations receives the information necessary to accept equipment for service use, let us follow a typical communication equipment through the test and evaluation process. When a Naval Technical Bureau decides that equipment will require an operational evaluation, the Bureau requests the Chief of Naval Operations to issue a test and evaluation project. When the project is issued, the Operational Tests and Evaluation Force begins its planning for the conduct of the tests. For the tests to be meaningful, the equipment must be thoroughly understood. Many routes of approach are used—study of previous evaluations on similar gear; study of laboratory and manufacturer's reports; examination of new techniques being utilized; discussions with the Developing Agency's personnel; trips to the contractor's plant to gain first hand information. Based on this knowledge, the various tests to be conducted during the operational evaluation will be formulated.

Although Commander Operational Test and Evaluation Force has certain fleet units available to conduct projects, these are augmented for particular projects to provide special capabilities. However, in an effort to reduce the number of fleet units that are required, sincere efforts are made to combine the services for several projects if no degradation of the data will result. Many operational problems must be resolved in order to provide the most desirable atmosphere for the evaluation.

Complex and detailed planning for the operational evaluation is required to provide valid answers to the many questions that may arise concerning a new equipment. Among these questions is the determination of the reliable range of a communication equipment. With increased dispersion for nuclear protection and the need for engagement of enemy forces at greater distances, naval tactical communication equipment has been called on to provide reliable communications at longer ranges. One approach to greater range has been the utilization of advanced techniques. For example, one new type of receiver was designed to receive emissions that were still in the experimental stage. In order to evaluate the receiver, special arrangements had to be made to schedule this type of emission during the experiments—an unusual situation.

During the entire operational evaluation, it is necessary to know the condition of the equipment in order to determine whether any change in power or sensitivity has occurred. To determine this, the equipment is constantly monitored. Normally the monitoring is done with standard shipboard test equipments, but special test equipment for more complete measurements is frequently utilized.

As electronic devices have become more sophisticated and complex, the ever recurring problem of maintenance must be considered. The Navy's concept of providing the maximum amount of maintenance and repair at the user activity, requires that the designer be aware constantly that the man repairing or maintaining his equipment on a ship or at an advanced base will not have the extensive electronic background possessed by the designer. Complicated alignment or troubleshooting procedures can render an equipment unsuitable

(Continued on page 81)

for service use. During operational evaluations, the service personnel of the ship or activity are required to perform the normal maintenance and repair instead of the contractor's representative. By this method, a good estimate of maintenance difficulties will be obtained. If a major failure occurs to the equipment that is beyond the capability of the integral maintenance personnel, the contractor may be consulted in order to expedite the conduct of the evaluation.

Since the equipment under evaluation will ultimately be maintained by service personnel, the adequacy of the instruction books and the maintenance manuals must be seriously considered. Circuit diagrams and component identification data are checked between the material and the books. If discrepancies exist, they are noted. Test procedures set forth in the maintenance manuals are conducted to ascertain whether they are compatible with the equipment and test equipment carried by the operating activity.

Also to be included in the plan for the tests are environmental problems. The effects of a ship's motion and vibration, and the susceptibility to corrosion by salt laden air will be determined. Airborne equipment will often be subjected to shocks by catapult takeoffs and arrested landings. Surface ship's equiment will be subjected to shock from missile firings.

As pointed out in the article by Rear Admiral Virden in the December 1959 issue of SIGNAL, entitled "Communication Requirements of Our Navy," mutual interference of electronic equipments is a serious and increasingly involved problem. During testing, personnel must be alert to detect interference. Special tests are often conducted, whereby other specific equipments are activated to learn how much and what type of interference is generated. Tests are conducted also to determine if intermodulation occurs. Unfortunately, interference is a problem that must be approached on a broader scale than the testing of each new equipment as it arrives.

In all communications equipments, frequency stability is an important feature which may be subjected to additional factors in afloat installations because of environmental conditions. As may be readily seen, temperature and humidity differences experienced in naval units could have a definite bearing on a unit's frequency stability. Extensive frequency measurements are taken during the tests to provide a basis for discussing stability.

Not all factors of an evaluation are derived from special tests. Some of the items are ascertained by examination of the equipment and by the objective observations of the personnel operating and maintaining the equipment. During the evaluation, the equipment is checked for the quality of workmanship. Such items as labeling of parts, soldering and cable dressing receive attention. Suitability of methods of mounting components and adequacy of materials used are noted. Safety devices and interlocks are carefully considered. These two items are especially important in the operating environment due to the motion of ships and aircraft. During heavy weather, personnel could easily be thrown against equipment and subjected to electrical shock. Additionally, the equipment could shear or jump interlocks or catches that would be adequate on a stable platform. Heavy weather also has adverse effects on moving hardware in equipments, i.e., carriages in teletype machines. Forces greater than normal due to motion of the ship may cause malfunctioning of these movable portions.

Nothing is more frustrating to a naval electronics technician than to spend several hours getting to a component that will require only a few moments to replace, especially when the "down status" of the equipment is critical to the operation of that particular fleet unit. Just as workmanship is checked, accessibility is investigated to determine if the equipment can be adequately maintained. This factor has become increasingly important as more complex and miniaturized assemblies appear in communication equipment. As a part of the evaluation, the operators are queried as to the usefulness and desirability of the various equipment controls and instrumentation.

Two problems that are related in part are ventilation and habitability. In the effort to provide our ships and aircraft with the greatest possible capability, more and more equipment has been installed. As a result, each new equipment must be considered with the view of whether it generates undesirable levels of light, heat or noise. Also, it must be determined whether the installation will reduce materially the space available for the other functions of a ship or aircraft.

If an equipment is planned for service use, personnel must be trained in its operation and maintenance. Observations must be made as to what training requirements and training aids will be required. When appropriate, the determination of doctrine for use of the equipment may be desired. Also, susceptibility of the equipment to countermeasures may be required.

After these manifold details of the tests are combined into a project plan and the equipment installed, the active prosecution of the project by a fleet unit commences. The fleet unit carries out the operations assigned by the project plan. As the data is accumulated, preliminary results are digested from the data. It may become apparent that certain modifications are needed in order to complete the evaluation. In this event, the Developing Agency is apprised of the situation and takes appropriate action. If modifications are minor, they may be accomplished at the test activity and the evaluation continued. However, major work may require removal of the equipment and suspension of the evaluation.

Upon conclusion of the tests, the prosecuting activity submits a report to Commander Operational Test and Evaluation Force. This report covers the specific items called for in the project plan plus any other items that may be pertinent. This report is utilized by the Staff of Commander Operational Test and Evaluation Force as a basis for the report to the Chief of Naval Operations. Based upon analysis and reduction of the data compiled during project operations, the report states specific facts concerning the equipment and recommendations as to the service acceptability of the equipment. These recommendations are made in the light of what improvement of Fleet capabilities this equipment offers and at what cost—not only in money but also in manpower, space requirements, maintenance and many other aspects.

As previously stated, the Operational Test and Evaluation Force does not set forth requirements for equipment. Its task is to test and evaluate equipments and concepts and then report to the Chief of Naval Operations. In its testing and evaluating, the Operational Test and Evaluation Force maintains the attitude of a hard shelled consumer who must be convinced of the worth of an equipment. When convinced, the Force becomes a strong advocate of the equipment.

In order to fulfill its many tasks in a troubled world, the Navy must insure that the equipment furnished to the Fleet units is the best obtainable and that it fulfills the requirement for which it was designed. The Navy will continue to have the best equipment if the appraisal of the equipment remains exacting and complete.

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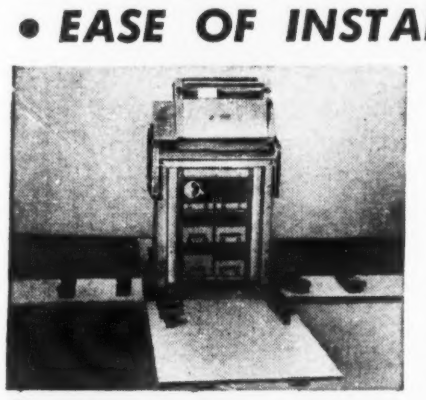
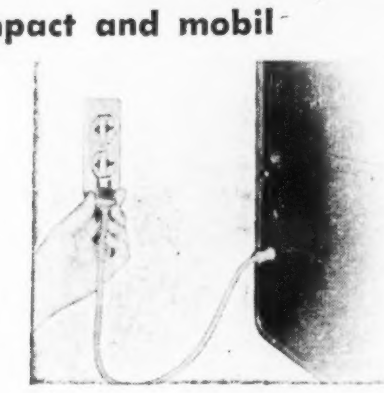


Uncrate

Roll in



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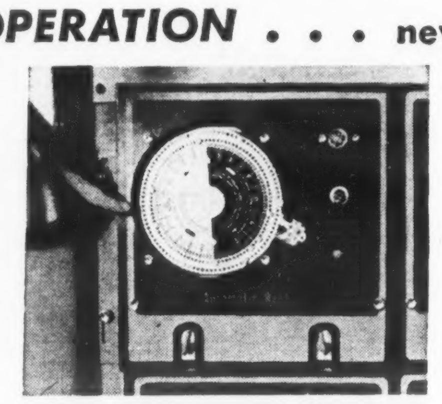
Clean crisp maps immediately

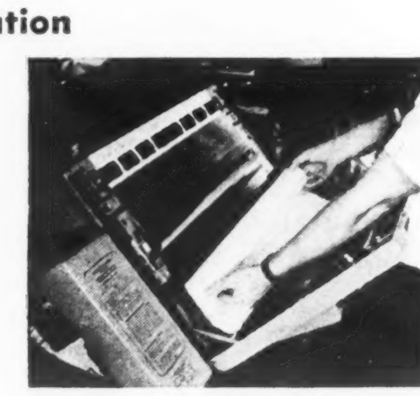
• EASE OF OPERATION . . . new high in clean, quiet operation

Automatic and continuous



Time clock programming

Instantly visible

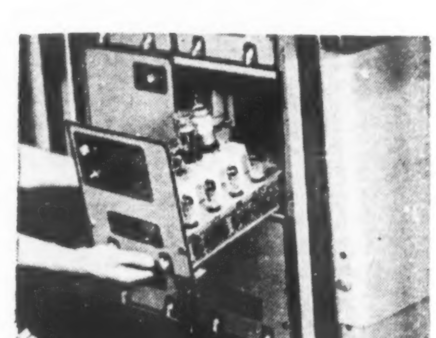


Easy paper loading

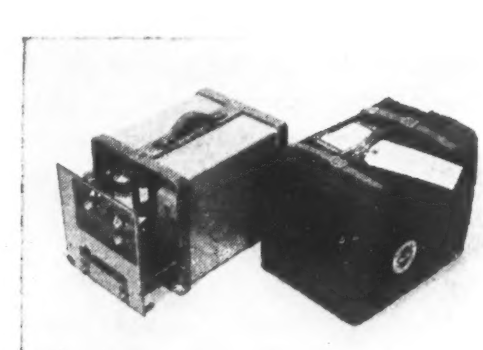
• EASE OF MAINTENANCE . . .

Front panel checks

Back connector checks



Plug-in construction



Air Freight replacement

• PLUS THESE UNIQUE FEATURES . . .

SECURITY—low voltage marking process does not generate a signal that can be intercepted.
HIGH SPEEDS—60-90 or 120 rpm operation . . . recorder technique and paper capable of fifteen times these existing speeds.
PRODUCTION—designed for volume production on short lead time . . . using unique expandable manufacturing techniques.

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ALDEN
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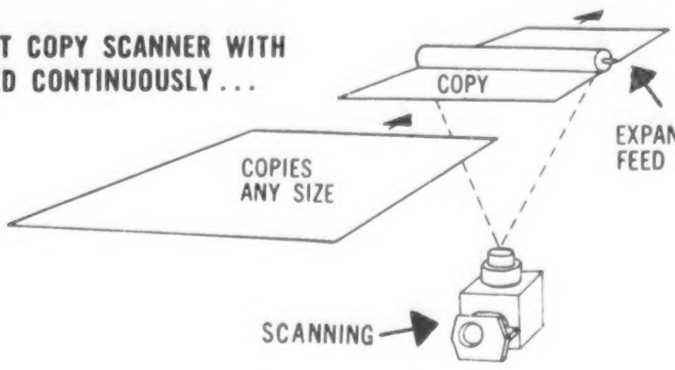
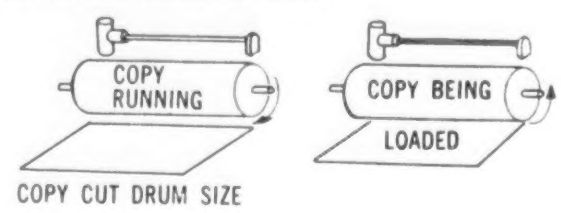
**NEW ERA IN CONTINUOUS FACSIMILE NETWORK OPERATION with ALDEN
...AT COPY SCANNING SYSTEM .** Compact, mobile flat copy scanners provided by Alden Electronic & ...pulse Recording Equipment Co., Inc., Westboro, Mass. moved onto the new U.S. Weather Bureau Hi-altitude Weather Facsimile ...twork Feb. 16, 1959 to begin a new era in simplified facsimile communications systems.

...E FLAT COPY SCANNER WITH
...PY FED CONTINUOUSLY...



... REPLACES 2 DRUMS AND 2 SCANNER HEADS



...AND ELIMINATES COPY SIZE LIMITATIONS

...LDEN FACSIMILE ...MAPS...

... and why we think ...ou'll like them too.

...ce 1954 Alden Facsimile Weather Map ...corders and Alfax maps have been replac... existing facsimile equipment on the ...tional facsimile Weather Map Network ...n accelerating rate.

...S. Weather Bureau stations converting to ...len equipment will be complete by the ... of the fiscal year with many independ... forecasters, air lines and institutions ...owing suit.

...e new U. S. Weather Bureau's high alti...e weather network, local and overseas ...works are being expanded with Alden ...simile Recorders and continuous flat copy ...nners.

...Fifteen out of twenty forecasters after having op...rating experience with all weather facsimile systems ...dicated a *marked preference for* Alden Recorders ...nd Alfax Maps.

...DEN ELECTRONIC AND IMPULSE ...CORDING EQUIPMENT CO., INC.

Westboro, Mass.

- **INSTALLATION SIMPLIFIED . . .**

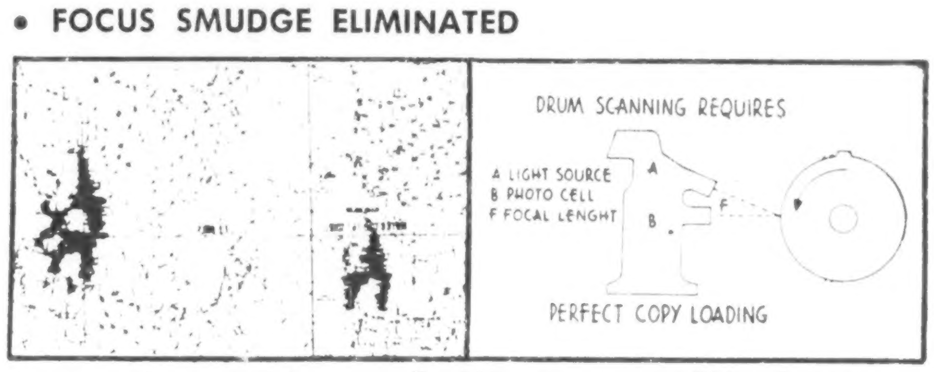
Uncrated from fold-a-way shipping boxes at Suitland, Maryland, and Idlewild, N.Y. — Alden scanners rolled in, plugged in and turned on to begin new era in weather facsimilie networks. Tested in 2 hours for 60, 90, 120 rpm, the equipment was turned over to the U.S. Weather Bureau personnel the same day. Addition of transmission and receiving points has been expanded with *higher speed operation* of 120 rpm started June 20th on completion of line balancing by American Telephone and Telegraph Co. which doubled the speed, transmitting copy of the same detail (size of characters and information *not* enlarged) as at 60 rpm.

- **EASE OF COPY HANDLING . . .**

With map sizes no longer restricted to drum mounting, continuous transmissions of maps (one after the other) with one scanner halves the space and maintenance problems, makes possible *scanning the original* plotted maps without cutting to size; map plotters and forecasters have *originals back in ½ the time.*

Flat Copy Scanner with expandable copy feed head takes maps any width or length — fed straight or kitty corner.

- **FOCUS SMUDGE ELIMINATED**



Focus smudge caused by unusually thick copy or copy lifting from drum

With copy feed rolls precisely positioning surface of map on flat copy scanner table, exact focal lengths are maintained for clear, sharp recordings.

- **MOST COMMENDED FEATURES**

Personnel familiar with prior facsimile scanning techniques, lauding this new breakthrough in weather facsimile techniques, highly commend these features:

- ease of copy handling
- compactness and mobility of equipment
- quietness and dependability of operation
- cleanness and sharpness of copy produced

Hi-Altitude Facsimile Weather Drops . . . are available from American Telephone and Telegraph Co. for qualified companies and organizations.
For others interested in facsimile communication systems, Alden Electronics makes flat copy scanner heads and recorders in all sizes and speeds (up to 30 times present network speeds), furnishing components to qualified manufacturers, and complete systems to end customers. *We invite your inquiry . .*

Association affairs

AFCEA Convention

Just a reminder—make your reservations now for the AFCEA Convention, May 24, 25, 26, at the Sheraton-Park Hotel, Washington, D. C.

Featured will be outstanding speakers, panels and exhibits. Admiral Arleigh Burke, Chief of Naval Operations, will speak at the Keynote Luncheon, May 24. Leo Cherne, Executive Director, Research Institute of America, will be the guest speaker at the Banquet, May 25. Lt. Gen. James D. O'Connell, USA (Ret.), Vice President, General Telephone and Electronics Corp., will speak at the Industrial Luncheon honoring 100 years of military communications, May 26.

Four morning panels will be presented during the three days. The National Aeronautics and Space Administration panel covers electronics for putting a man into space, May 24. Problems of satellite communications will be discussed at the Bell Telephone Laboratories, Inc. panel, May 25. A panel on photography will be held May 25. General Electric Co. will present an industry reports panel on new horizons in point-to-point communications, and other subjects, May 26.

Conventioneers will be assured of seeing excellent military and industry exhibits. Booth space has been sold out completely even with an added exhibit area.

David Sarnoff Honored

Brigadier General David Sarnoff, chairman of the board, Radio Corporation of America, was honored by the Radio and Television Executives' Society at its twentieth anniversary dinner, March 10, in New York City.

General Sarnoff received the first RTES Gold Medal award "for outstanding contributions to broadcasting."

General Sarnoff was the first national president of AFCEA and now is a director of the association.

Communications Film for Chapters

A communications film which tells the story of the Airways and Air Communication Service is available, on a loan basis, to AFCEA chapters in the Washington, D. C., area through the end of May.

Presented in color, the 20-minute film describes how the AACS serves the Air Force with point-to-point and air-ground-air communications, navigational aids, flight service facilities and aircraft control.

The film is being made available through the policy group of the Communications - Electronic Directorate, Headquarters USAF.

Other chapters may obtain communications films from the Air Force Film Library, 89 South Broadway, St. Louis, Mo., or from any Air Force installation.

New Sustaining Member

General Electric Co. has taken out a sustaining membership for its Defense Electronics Division. Four Departments in the division will be represented.

Representatives in the Light Military Electronics Dept. are C. D. Brown, H. F. Konig, W. J. Kuehl, W. A. Kinnaman, J. L. Komer, B. L. Pfefer, D. E. Garr, G. R. Harris and M. R. Johnson.

Heavy Military Electronics Dept. members in AFCEA include C. E. Beard, R. J. Brown, F. Gangberg, H. Mease, Jr., L. H. Naum, G. D. Prestwich, J. R. Wescott and F. R. Prentice.

For the Missile and Space Vehicle Dept. the representatives are M. Arnold, D. T. Atkinson, G. Briney, W. E. Conner, L. Cowles, M. Morton, B. V. O'Brien, R. E. Roberts and F. E. Rushlow.

Those members in the Defense Systems Dept. are R. L. Shetler, W. R. Sinback, R. G. Henry, A. T. Schade, L. E. Saline, R. M. Vredenburg, C. D. Small, C. E. Bold and A. A. Fickel.

New Group Member

Bendix Systems Div., Bendix Aviation Corp., is a new group member. Engaged in research and development work in Ann Arbor, Michigan, the division is the second Bendix group now affiliated with AFCEA. Bendix Radio Div. joined the association in 1946.

Maj. Carl L. Lisbeth, USAF, president of the Greater Detroit chapter, will present the group certificate to Bendix System officials at a future chapter meeting.

Representatives for the division are R. J. Sandstrom, General Manager; J. A. Burns, Director, Long Range Planning; J. E. Browder, Program Director; L. G. Mundie, Head, Infrared & Optical Dept.; N. P. Cedrone, Technical Director; J. W. McNabb, Head, Communications Dept.; L. E. Newland, Engineer; C. E. Kent, Engineer; K. D. Jacob, Engineer; E. S. Van Valkenburg, Head, Data Processing & Display Dept.

As we go to press we have learned that Associated Electrical Industries Ltd. and The Martin Co. have become group members. Company listings will appear next month.

NEW MEMBERS

Listed below are new members of the AFCEA who have joined the Association during the month of February. Members are listed under the chapter with which they are affiliated. The March listing will appear in the May issue.

Atlanta
Belton F. Clark
Joel S. Williams
Arthur C. Willson
Julian L. Crook
Arthur Bleakley
E. H. Stewart
Clarence Pinson
George M. Key
James L. Wallace
Lt. Col. Emmett J. Welch

Augusta-Fort Gordon
John W. Owen
Dennis W. Adams
SFC Jack L. Cooper
Major Robert Jack Emerson

Boston
E. Thomas Casellini
Capt. Rowland T. Moritz
Thomas T. Hill

Chicago
Dr. Richard C. Becker
A. W. Weisberg
Lee E. Strickland
Russell J. Kemp
Eugene A. Rasco
Ronald L. Dahlgren
John W. Ayers
Herbert F. Motz
Herbert Bartholomay
Richard E. Zucker
Robert L. Larsen
Harold R. Heckendorn
Irwin D. Bereskin
Frank J. Rychlik
William E. Nickle
Virgle E. Porter
Albert D. Wack
Frank A. Hufana
William J. Brady

Dayton-Wright
Joseph A. Kozusko
John G. Sample
John P. Turner
Thomas R. Poston
John F. Myers
John J. Andrews
Cdr. R. Benson Varner
Frederick J. Langan

Decatur
Capt. Frank P. Matz
William E. Weaver
John R. Martin
Lester E. Harlin
Finis L. Meadows
Robert B. Eckles
Roy A. Cartler
Robert M. Burns

Fort Monmouth
James E. Ruthledge
Charles F. Johnson
Seymour Krevsky
Maj. James L. Jones
Lt. Col. Harry W. Parmer
Frank A. Gimpel
Capt. William F. Luebbert
Wolfgang W. Gaertner
Brough M. Gipe
Kenneth M. Napier
Robert J. Maltby
Major Thomas E. McNeary
Bernice C. Skutas
Michael S. Ikonomou
Col. John L. Wilson, Jr.
Francis W. Palmer
Edwin L. Moore
Major Florence M. Belknap
2nd Lt. Thomas M. Halfpenny
Hubert Cahn
Capt. Elmer A. Brown
2nd Lt. Edward C. Horey, Jr.
Col. M. R. Kunitz
Major Charles W. Johnson, Jr.
Mr. Andrew Reiseman
Michael J. Vrentas

Frankfurt
Major Fred L. Young
SP-5 Russell B. Geis
1st Lt. Farrell G. Patrick

Gulf Coast
Capt. R. C. Cox
Christine Smith
Capt. John W. Gledhill
T. H. Bailey
Lt. William F. Moore

Hawaii
Manuel D. Pires

Kansas City
William E. Hanneman
William P. Raborn
F. S. Mockford

New York
Thompson D. Berry
John F. Healy
Frederick C. Miller
Arthur E. Mann
I. Nevin Palley
Gen. Roy H. Lynn
Leonard C. Davidson
Harold Carlson
Lt. Col. Charles Wurth
Ivan Sohonyay
Alfred Di Scipio

North Carolina
Frank M. Hayes
J. J. Smith
James C. Brooks
Brig. Gen. Joseph W. Stilwell, Jr.

North Texas
Clyde M. Bell
Cdr. Rupert D. Phillips

North West Florida
Preston J. Brewster
Albert O. Cooper

Orange
Richard E. Jones

Philadelphia
Ruth E. Dempsey
Capt. James M. Kauffman
Lt. Col. Thomas D. Callahan
B. Shuman
J. Wojcik

Pittsburgh
Bruce Goss

Rocky Mountain
S-Sgt. Herbert A. Ballard
Beryl M. Woods
William A. Daugherty
Vernon L. Grimes
George H. Nankervis
William K. Dunn
Willis J. Griffee

Rome-Utica
Bernard Cooper

Sacramento
Capt. Robert J. McMorrow
William C. Shalag

San Francisco
Alan F. Culbertson
Kenneth R. Pierce
Myron C. Pogue

San Juan
SP-5 Leroy D. Armstrong
John B. O'Brien
Merle M. Long
Vincent Aponte

Scott-St. Louis
Capt. Edmund J. Smith

Santa Barbara
Christopher Nicholas

South Carolina
Richard C. Mathis
William W. Guntee
LCdr. E. Ray Kickel

South Texas
Glenn M. Countryman
Kenneth C. Robertson

Southern California
Dale G. McBride
Warren L. Clark
Glen P. Bieging
T. Howard Scarborough
Burton Reiman
Will Connelly

Syracuse
Comdr. Sam W. Agee
Stedman B. Bird
Allen O. Blacklock, Jr.
William G. Burns
James K. Chapman
Comdr. John B. Cornett
J. Kent Cushman
Michael R. DeLallo
Channing Dichter
Richard J. Goggins
Raymond Haney
Donald W. Harris
Eugene E. Maynard
Robert E. McBride
George E. McGilura
Wharton L. McGreer
Ray A. Miller
Edson G. Moshier
Richard R. Overeem
H. Earl Revercomb
Joseph L. Snyder
Benjamin P. Ransom
Felix C. Cassenti
Rodney L. Swift
Clare K. Fulton
William F. Squires

Tinker-Oklahoma City
Merle D. Burchardt
Floyd C. Hurst
Harold T. Alexander
Lt. Cdr. Lewis C. Shepley
Leslie P. Laing
Joseph R. Barton
David P. Allen

Tokyo
Jack Goss

Washington
Dale Ness
E. J. Haley
Col. Horace W. Lanford, Jr.
Richard S. Moore
John J. Murphy

Member at Large
Lt. Col. Robert E. Larson

AFCEA Sustaining and Group Members

Communications—Electronics—Photography

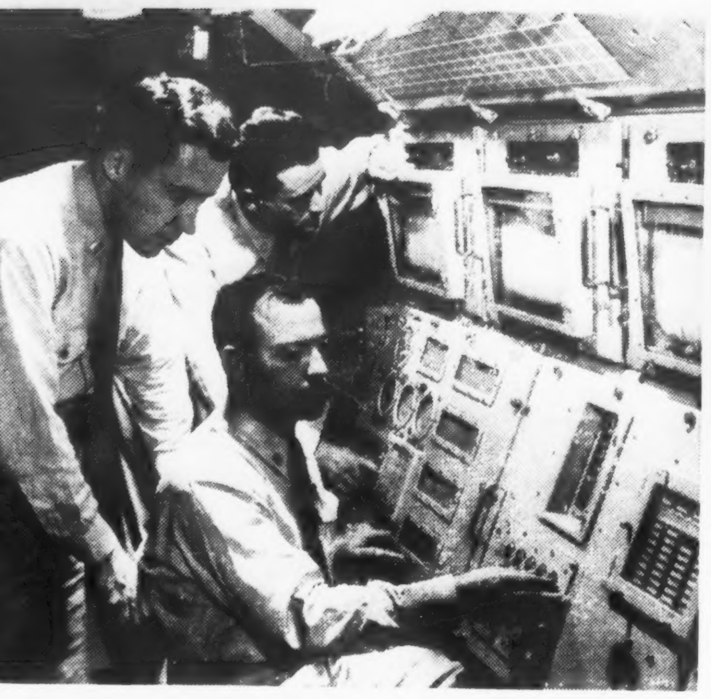
Listed below are the firms who are sustaining and group members of the Armed Forces Communications and Electronics Association. By their membership they indicate their readiness for their share in industry's part in national security. Each firm nominates several of its key employees or officials for individual membership in AFCEA, thus forming a group of the highest trained men in the electronics and photographic fields, available for advice and assistance to the armed services on research, development, manufacturing, procurement, and operation.

Sustaining Members

Cook Electric Co.
General Electric Co., Defense Electronics Div.
International Telephone & Telegraph Corp.
New York Telephone Co.

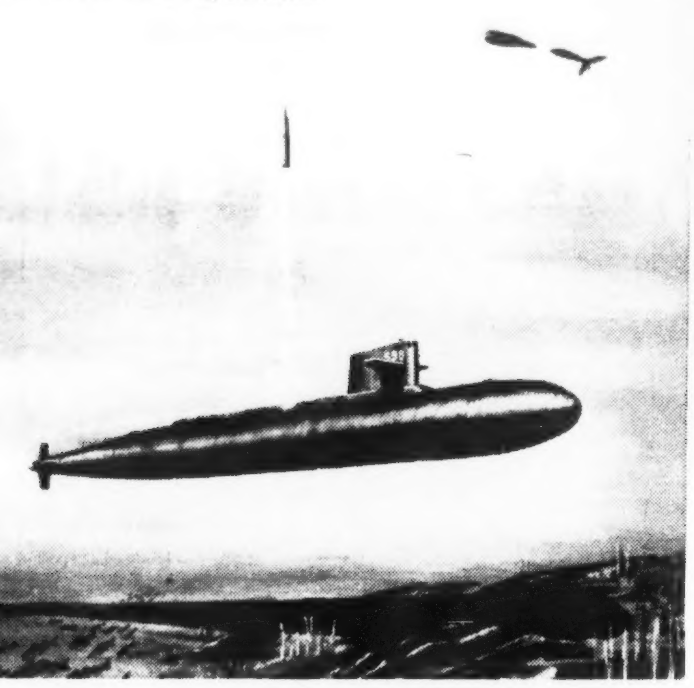
Group Members

Adler Electronics, Inc.
Admiral Corp.
Allied Control Co., Inc.
Allied Radio Corp.
American Cable & Radio Corp.
American Institute of Electrical Engineers
American Machine & Foundry Co.
American Radio Relay League
American Telephone & Telegraph Co.
American Telephone & Telegraph Co., Long Lines Dept.
Amphenol/Borg Electronics Corp.
Anaconda Wire & Cable Co.
Andrew Corp.
Arnold Engineering Co.
Associated Electrical Industries Ltd.
Atlas Film Corp.
Atlas Precision Products Co.
Automatic Electric Co.
Automatic Electric Sales Corp.
Automatic Telephone & Electric Co., Ltd.
Autonetics, Division of North American Aviation, Inc.
Barry Controls, Inc.
Beiser Aviation Corp.
Bell Telephone Company of Pa.
Bell Telephone Laboratories, Inc.
Bendix Radio Division, Bendix Aviation Corp.
Bendix Systems Division, Bendix Aviation Corp.
Bliley Electric Co.
British Thomson-Houston Co., Ltd.
Bruno-New York Industries Corp.
Budd Lewyt Electronics, Inc.
Burroughs Corp.
California Water & Telephone Co.
Cambridge Thermionic Corp.
Capitol Radio Engineering Institute, Inc.
Carolina Telephone & Telegraph Co.
Central Technical Institute
Chesapeake & Potomac Tel. Co.
Cincinnati & Suburban Bell Tel. Co.
Collins Radio Co.
Columbia Broadcasting System, Inc.
Contraves Italiana
Convair, Division of General Dynamics Corp.
William C. Copp & Associates
Copperweld Steel Co.
Cornell-Dubilier Electric Corp.
A. C. Cossor Ltd.
Craig Systems, Inc.
Crosley Division-Avco Corp.
Decca Navigator Co. Ltd.
Designers For Industry, Inc.
Diamond State Telephone Co.
Dictaphone Corp.
DuKane Corp.
Du Mont, Allen B., Laboratories, Inc.
Eastman Kodak Co.
Electronic Associates, Inc.
Electronic Communications, Inc.
Elgin Metalformers Corp.
Fairchild Camera & Instrument Corp.
General Analysis Corp.
General Aniline & Film Corp.
General Communication Co.
General Telephone & Electronics Corp.
Gilfillan Bros., Inc.
Globe Wireless, Ltd.
Gray Manufacturing Co.
Hallamore Electronics Co.
Hallicrafters Co., The
Haloid Xerox Inc.
Hazeltine Electronics Division, Hazeltine Corp.
Heinemann Electric Co.
Hoffman Electronics Corp., Military Products Div.
William F. Hogan Associates, Inc.
Hughes Aircraft Co.
Illinois Bell Telephone Co.
Indiana Bell Telephone Co.
Indiana Steel & Wire Co.
Institute of Radio Engineers
Instruments for Industry, Inc.
International Business Machines
International Resistance Co.
Jacobsen Manufacturing Co.
Jansky & Bailey, Inc.
Jerrold Electronics Corp.
Kellogg Switchboard & Supply Co.
Kleinschmidt Laboratories, Inc.
Leich Sales Corp.
Lenkurt Electric Co.
Ling-Altec Electronics, Inc.
Litton Industries, Inc.
Lockheed Aircraft Corporation
Machlett Laboratories, Inc.
Magnavox Co.
Marconi's Wireless Telegraph Co. Ltd.
Martin Co., The
Materiel Telephonique Co.
McCoy Electronics Co.
Michigan Bell Telephone Co.
Montgomery Co., The
Motorola Inc.
Mountain States Telephone & Telegraph Co.
Mullard Ltd.
Muter Co., Rola & Jensen Divisions
Mycalex Corporation of America
National Co., Inc.
Nems-Clarke Co., Div. of Vitro Corp. of America
New England Tel. & Tel. Co.
New Jersey Bell Telephone Co.
North Electric Co.
Northwestern Bell Telephone Co.
Oak Manufacturing Co.
Ohio Bell Telephone Co.
O'Keefe & Merritt Co.
Pacific Telephone & Telegraph Co.
Packard-Bell Electronics Corp.
Page Communications Engineers, Inc.
Phelps Dodge Copper Products Corp.
Philco Corp.
Photographic Society of America
Plessey Co., Ltd.
Prodelin Inc.
Radiation, Inc.
Radio Corporation of America
Radio Corporation of America, Astro-Electronic Products Div.
Radio Corporation of America, Defense Electronic Products
RCA Great Britain, Ltd.
Radio Engineering Laboratories, Inc.
Radio Frequency Laboratories, Inc.
Ramo-Wooldridge, Division of Thompson Ramo Wooldridge Inc.
Raytheon Co.
Red Bank Division, Bendix Aviation Corp.
Reeves Instrument Corp.
Rixon Electronics, Inc.
Rocke International Corp.
Saxonburg Ceramics, Inc.
Scanner Corporation of America, Inc.
Servo Corporation of America
Singer Manufacturing Co., The Military Products Division
Smith-Corona Marchant Inc., Research and Development Division
Society of Motion Picture & Television Engineers
SoundScriber Corp., The
Southern Bell Telephone & Telegraph Co.
Southern New England Telephone Co
Southwestern Bell Telephone Co.
Sperry Gyroscope Co., Division of Sperry Rand Corp.
Sprague Electric Co.
Stackpole Carbon Co.
Standard Electronics Co.
Standard Telephones & Cables, Ltd.
Stanford Research Institute
Stewart-Warner Corp.
Stromberg-Carlson Co., Division of General Dynamics Corp.
Surprenant Mfg. Co.
Sylvania Electric Products, Inc.
Technical Materiel Corp., The
Telectro Industries Corp.
Tele-Dynamics, Inc.
Telephonics Corp.
Teleprinter Corp.
Teletype Corp.
Texas Instruments Incorporated
T.M.C. (Canada) Ltd.
Trans-Sonics, Inc.
Tung-Sol Electric, Inc.
Union Carbide Corp.
United Telephone Co.
United Transformer Co.
Varian Associates
Webcor, Inc., Government Division
West Coast Telephone Co.
Western Electric Co., Inc.
Western Union Telegraph Co.
Westinghouse Electric Corp.
Westrex Corp.
Wheelock Signals, Inc.
Wilcox Electric Co., Inc.
Wisconsin Telephone Co.
Wollensak Optical Co.
Zenith Radio Corp.



CREW EDUCATION in operational procedure includes rundown on Navigation Control Console and NAVDAC—Sperry computer which cross-checks a dozen systems, compares references, records speeds, integrates all data for precise positioning of submarine.

POSSIBLE LAUNCH-SITE: UNDER THE ARCTIC ICE-PACK. Nuclear subs will be able to stay submerged, navigate for months without refueling, launch Polaris under water. Range places new demands on navigational resources and capabilities.



FULL-SCALE SUB SIMULATOR duplicates complex navigational equipment that will guide actual Polaris submarines. To fit systems in restricted space, everything from cabling to 62-ton Gyroscopic Stabilizer must be "engineered" into the hull.

"Dry Run" For The Missile-Launching Subs

Aiming the 1200-mile Polaris missile from a submerged nuclear sub will pose a delicate navigation problem. Engineers are solving it in a unique "underseas" laboratory.

(ONE OF A SERIES)

THE STORY BEHIND THE STORY
of Sperry Marine Division

The Navy's goal of "Seapower for Peace" is nearer with each step towards operational capability of the new missile-carrying submarines. When armed with Polaris missiles, these subs will represent an unprecedented counter-punch capable of reaching targets 1200 miles away, from anywhere in the world's oceans.

The Polaris concept places critical demands on the art of navigation. A single degree of error can result in a 17-mile error in a thousand-mile range. To Sperry's Marine Division—appointed by the Navy to Navigation Systems Management of the newest class of Polaris submarines—is assigned the job of assuring highest possible system accuracy.

Working with the Navy's Polaris experts, Sperry engineers are installing, operating and evaluating instruments and systems for the Polaris at Sperry's "Navigation Island"—a shore-based replica of the navigation center in the Polaris submarines. Here installation and operating problems and techniques, maneuvers, emergencies, even the stars for celestial navigation, are "shot" under realistic conditions.

One system is Sperry's NAVDAC (Navigation Data Assimilation Center)—a computer which analyzes information fed to it from the navigation equipment that will eventually position the Polaris subs for missile firing. Basic to a number of the subs is Sperry SINS (Ship's Inertial Navigation System) equipment. These and other advanced systems are being evaluated and refined.

With the Navy's foresight in "interlocking" all aspects of the Polaris program . . . and with the cooperation of the many leading industries which are contributing . . . the Polaris subs will soon be operational. Marine Division, Sperry Gyroscope Company, Division of Sperry Rand Corp., Syosset, New York.

SPERRY

AFCEA CHAPTERS AND CHAPTER OFFICERS

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Region B1: George C. Ruehl, Jr., Electronic Specialties Co., 2118 St. Paul Street, Baltimore, Md. ***Delaware, District of Columbia, Maryland, Eastern Pennsylvania and Virginia.***

Region B2: Paul H. Clark, Radio Corporation of America, 224 N. Wilkinson St., Dayton, Ohio. ***Kentucky, Ohio, West Virginia and Western Pennsylvania.***

Region C: W. K. Mosley, Southern Bell T&T Co., Hurt Bldg., Atlanta, Ga. ***Southeastern States along Atlantic and Gulf coasts—from North Carolina to Louisiana including Tennessee.***

Region D: Maj. Gen. Harry Reichelderfer, USA (Ret.), Southwest Research Institute, 8500 Culebra Rd., San Antonio, Tex. ***New Mexico, Texas, Oklahoma, Arkansas.***

Region E: Walter H. Pagenkopf, Teletype Corp., 5555 Touhy Ave., Skokie, Ill. ***Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Nebraska, North Dakota, South Dakota, Wyoming, Colorado.***

Region F: Ray E. Meyers, 717 Anderson Way, San Gabriel, Calif. ***Arizona, Utah, Nevada, California, Idaho, Oregon, Montana and Washington.***

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DECATUR: Pres.—Capt. Frank Matz, 505 Nelson Blvd., Decatur, Ill. Sec.—David Honn, 659 W. William St., Decatur. Ill.

FORT MONMOUTH: Pres.—Norman K. Freeman, Stromberg-Carlson, P. O. Box 127, Shrewsbury, N. J. Sec.—Harry C. Ross, Box 249, Hillside Rd., Atlantic Highlands, N. J.

FRANKFURT: Treas.—Ralph L. Prokop, USA Procurement Center, APO 757, N. Y.

GULF COAST: Pres.—Lt. Col. George S. Walborn, 174 St. Andrews FWY, Biloxi, Miss. Sec.—Leland E. Kelly, 104 45th St., Gulfport, Miss.

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KANSAS CITY: Pres.—Col. Leslie C. Heartz, 13604 Applewood Drive, Grandview, Mo. Sec.—Charles E. Sevier, SW Bell Tel Co., 324 E. 11th St., Kansas City.

KOREAN: Sec.—William L. Wardell, OEC, RD-CD, APO 301, S. F.

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ORANGE: Pres.—Maj. Morris Muse, USAF, Hq. Air Rescue Service, Orlando AFB, Fla. Sec.—Lt. Col. James A. Trutter, Radiation Inc., P.O. Box 6904, Orlando, Fla.

PARIS: Pres.—Rear Adm. Henry C. Bruton, Hq. US EUCOM, C-E, APO 128, New York. Sec.—Lt. Col. Philip H. McCorkle, Hq. US EUCOM, Comm-Elect., APO 128, New York.

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PHILIPPINE: Pres.—Manuel A. Vargas, Hq 13th Air Force OAC, APO 74, S. F.

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ROCKY MOUNTAIN: Pres.—Col. Howard S. Gee, 3010 Maizeland Rd., Colorado Springs, Colo. Sec.—Maj. C. W. McKelvie, Hq. ADC, Ent AFB.

ROME-UTICA: Pres.—Murray Socolof, 811 Bradford Drive, Rome, N. Y. Sec.—Robert F. Weil, The Paul Revere, Turin Road, Rome, N. Y.

SACRAMENTO: Sec.—Capt. Robert McMorrow, 951 La Sierra Drive.

SAN DIEGO: Pres.—Cmdr. Samuel Freedman, Chemalloy Electronics Corp., Gillespie Airport, Santee, Calif.

SAN FRANCISCO: Pres.—H. L. Schnoor, Pacific Tel. & Tel. Co., 140 New Montgomery St. San Francisco 5, Cal. Sec—Elmo Simmons, Pacific Tel & Tel. Co., 140 New Montgomery St., San Francisco 5, Cal.

SAN JUAN: Pres.—Cdr. Harry C. Rodin, USN, 10th Naval District, U. S. Naval Sta., San Juan, P. R. Sec.—Albert R. Crumley, Crumley Radio Corp., Box 10073, Caparra Heights, San Juan, P. R.

SANTA BARBARA: Pres.—RAdm. Clarence C. Ray, 63 Manzanita Lane, Star Route, Santa Barbara, Cal. Sec.—Walter W. Montgomery, Raytheon Co., P. O. Box 636, Santa Barbara.

SCOTT-ST. LOUIS: Pres.—Col. George A. Zahn, Hq. AACS, DCS/COMM, Scott AFB, Ill. Sec. — Allan L. Eisenmayer, P.O. Box 456, Trenton, Ill.

SEATTLE: Pres.—Cdr. Leo J. Larkin, Naval Communications Station Seattle, Seattle 99, Wash. Sec.—J. Alan Duncan, 6836 29th Ave., N. E., Seattle 15, Wash.

SOUTH CAROLINA: Pres.—E. D. Biggerstaff, Jr., Charleston Naval Shipyards, Charleston, S. C. Sec.—Donald D. Harris, Southern Bell T&T Co., Owen Bldg., Columbia, S. C.

SOUTH TEXAS: Pres. — Col. Hugh F. Moreland, U.S.A.F. Security Service, San Antonio, Tex. Sec.—John D. Rainbolt, Southwestern Bell Tel. Co., 301 Broadway, San Antonio.

SOUTHERN CALIFORNIA: Pres. — John W [illegible]wood, Western Union, 745 So. Flower St., Los Angeles. Sec.—D. G. Soergel, Development Planning, 1700 E. Imperial Highway, El Segundo, Cal.

SOUTHERN CONNECTICUT: Pres.—John N. Higgins, KIP Electronics Corp., 29 Holly Pl., Stamford, Conn. Sec.—J. A. Leopold, Dictaphone Corp., 375 Howard Ave., Bridgeport.

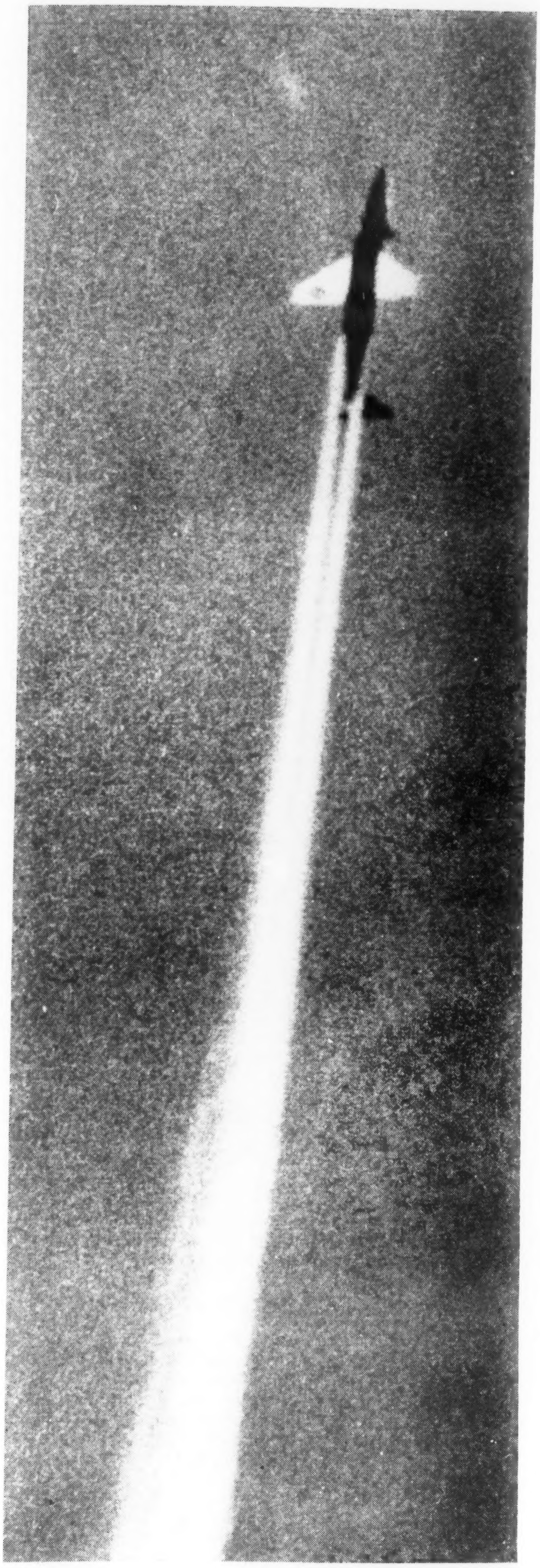
SWITZERLAND: Pres.—Capt. Gerald C. Gross, USNR, Intl. Telecommunications Union, Geneva. Sec.—Robert V. Lindsey, Intl Telecommunications Union, Geneva.

SYRACUSE: Pres.—Colin W. Getz, New York Telephone Co., 108 West Fayette St., Syracuse, N. Y. Sec.—John G. Labedz, Lyndon Road, Fayetteville, N. Y.

TINKER-OKLAHOMA CITY: Pres.—Lt. Col. George L. Timme, Jr., GEEIA Rgn., Tinker AFB, Okla. Sec.—Maj. John L. Whyatt, 3rd AACS Sqdn. (Mob), Tinker AFB.

TOKYO: Pres. — Col. Bradford H. Wells, USAF J-6, APO 925, S. F. Sec.—G. F. Gray, RCA International Service Corp., Far East Office, APO 323, San Francisco, Cal.

WASHINGTON: Pres.—A. W. Christopher, Sylvania Electric, 734 15th St., N.W., Washington, D. C. Sec.—H. H. Schroeder, AT&T Co., 1001 Connecticut Ave., N.W., Washington, D. C.



Chapter News

Atlanta

Chapter President A. E. Arnold departed from the usual and invited the ladies to the dinner-meeting held at the Fort McPherson Officers Club on January 19. The response was good and a near record attendance of 225 members and guests were on hand. Among the distinguished visitors was Maj. Gen. Wm. O. Reeder, retired deputy commander, U. S. Signal Corps.

The guest speaker, Leo Aikman, editorial Assistant and Columnist, *Atlanta Constitution*, was introduced by Col. Kirk Buchak, Signal Officer, Third Army. Mr. Aikman, a speaker of national prominence, chose as his subject, "Travel at Your Own Risk," which has reference to the journey of life. He dealt with the importance of communication between individuals and nations, and termed it a key to peace. His wit and humor made the evening a most entertaining and rewarding one for everyone present.

Baltimore

The February meeting was held at the U. S. Coast Guard Yards at Curtis Bay. The meeting featured a presentation on "Visual Communications" by Mr. Robert M. Dibble, specialist in audio and visual communications of the Tecnifax Corporation of Holyoke, Mass. In addition, members were shown a new color film highlighting the activities of the Buoy Tender *Azalea*.

Boston

Dr. Ivan A. Getting, Vice President of Engineering and Research, Raytheon Co., Waltham, was guest speaker at the March dinner meeting of the chapter.

Dr. Getting spoke on the subject, *The Extremes of Radio Frequency Power in the Space Age*. Dr. Getting has been associated with Raytheon since 1951 and formerly served as Assistant for Planning, USAF. From 1940 to 1950 he was affiliated with the Massachusetts Institute of Technology, first as Director of Fire Control and Army Radar in the Radiation Laboratory and later as Director of the staff that built the 350 million electron volt atom smasher at MIT.

Decatur

At the annual election of officers, the following were selected to office: president—Capt. Frank Matz; vice president—Edward J. Maloney; secretary—David Honn; treasurer—Wilbur Smith; board of directors—Roy Cartier, Norman Haug and Kenneth Poole.

On February 23 the chapter met at the Signal Officers' Mess for a dinner meeting followed by a program of films.

Fort Monmouth

Clifford D. May, Jr., technical director, Army Communications Service Division, Office of the Chief Signal Officer, was the guest speaker at the February dinner meeting. His subject was "Army Global Communications."

Mr. May, who has numerous Department of the Army awards for inventions in the communications field, has also made many contributions to technical organizations of the Army's UNICOM program, and to the national communication satellite program.

The meeting, held at Gibbs Hall Officers' Club, drew a large attendance of military and civilian personnel, as well as groups and individuals from local and regional industrial firms.

A dinner-meeting was held March 17 in the Sapphire Room of Gibbs Hall.

Guest speaker was James McMillion, Coordinator of Camera Club Services for Ansco, Binghamton, N. Y. Mr. McMillion formerly was an instructor of photography at Ohio University and has earned several merit awards from various state and national organizations for his photographs. He presented practical ways to improve color shots and displayed numerous slides to show the advantages color photography has to offer.

Mr. McMillion's talk was based on the philosophy that a person will enjoy color photography more if he has a basic understanding of how the process works.

Gulf Coast

The chapter held its meeting on February 1 at the Airmen's Club, Keesler AFB, where seventy-nine members and guests were present.

Following the dinner and business meeting, various departments of Keesler AFB Electronics School and Southern Bell Telephone Company were recognized.

Mr. Howard Yund made a report on future programs and then introduced Mr. Francis Lundy, Hattiesburg District Commercial Manager, who presented the Bell Science film, "Unchained Goddess."

Kansas City

The Officers' Club at Richards Gebaur Air Force Base was the scene of the chapter's January 28th dinner meeting.

The guest speaker of the evening was Dr. Snyder of the Midwest Research Institute of Kansas City. Dr. Snyder discussed the activities and capabilities of the Institute and explained some of the projects that the organization is involved with at the present time ranging from cancer research to defense projects.

At a special meeting of the chapter's board of directors, Colonel Leslie C. Heartz, USAF, was named president of the chapter, filling the vacancy caused by President Fisher's transfer to Dallas.

Louisiana

Dr. James H. Allen, Director of Ophthalmology at Tulane University, and Samuel Carleton discussed "The Human Eye in Military Communications" at the March 15 chapter meeting at the Camp Leroy Johnson Commissioned Officers Mess.

A social hour and dinner preceded the meeting.

New York

Colonel J. Z. Millar, Assistant Vice President of Western Union Telegraph Company spoke on the subject of combat-logistics networks at the Chapter's January 27th meeting at the Belmont Plaza Hotel.

Colonel Millar, long an active member of the chapter, reviewed the worldwide aspects of a most advanced digital data system, the combat-logistics network, which is an automatic all-electronic and completely transistorized high-speed transmission and switching network. Special emphasis was placed upon the operating requirements of this advanced automatic network with a preview given on the technical features of the equipment.

At the February 24th meeting, Dr. Leonard S. Sheingold, Director, Applied Research Laboratory, Sylvania Electronic Systems, Division of General Telephone and Electronics Corp., discussed "Communications Research."

Dr. Sheingold outlined trends in communications over the next 20-30 years and the impact that communications will have on our military posture as well as our civilian way of life.

North Carolina

The Chapter held a dinner meeting Wednesday evening February 3 in the John R. Hodge Room of the Fort Bragg Officers Open Mess with 34 members and 12 guests present.

Chapter president Edwards named the following as a nominating committee to select the officers for the chapter for the next year: Mr. William H. Ross, Chairman, Mr. Matthew C. Crisp and Major Jim Russell. These nominations will be presented at the next meeting.

(*Continued on page 92*)

Atlanta—*Shown at the January meeting are L to R: Lt. Col. Thomas A. Pugh, vice-pres.; Mr. Leo Aikman of the Atlanta Constitution, principal speaker; Lt. Col. Luther J. Rose, vice-pres.; Mr. A. E. Arnold, president of the chapter.*

Chicago—*Pictured at the January meeting are L to R: M. Goetz, Pres., Teletype Corp.; B. H. Oliver, Jr., AFCEA National Pres.; Walt Pagenkopf, V.P. of Teletype and Reg. V.P. of AFCEA; A. Schmitt, Chairman of the Board, Amphenol-Borg Electronics Corp.; G. Ruehl, Reg. V.P. of AFCEA; A. P. Lancaster, V.P., Western Electric Co., G. Montgomery, Reg. V.P., AFCEA; Col. F. Ostenberg, Headquarters, AFCEA, and W. Zenner, V.P., Teletype.*

Fort Monmouth—*Talking things over at the February meeting are L to R: Brig. Gen. Charles M. Baer, Commandant, USA Signal School; Clifford D. May, Jr., OCSigO, guest speaker; Norman K. Freeman, chapter president, and Lloyd Christensen, President, Electronics Associates, Long Branch, N. J.*

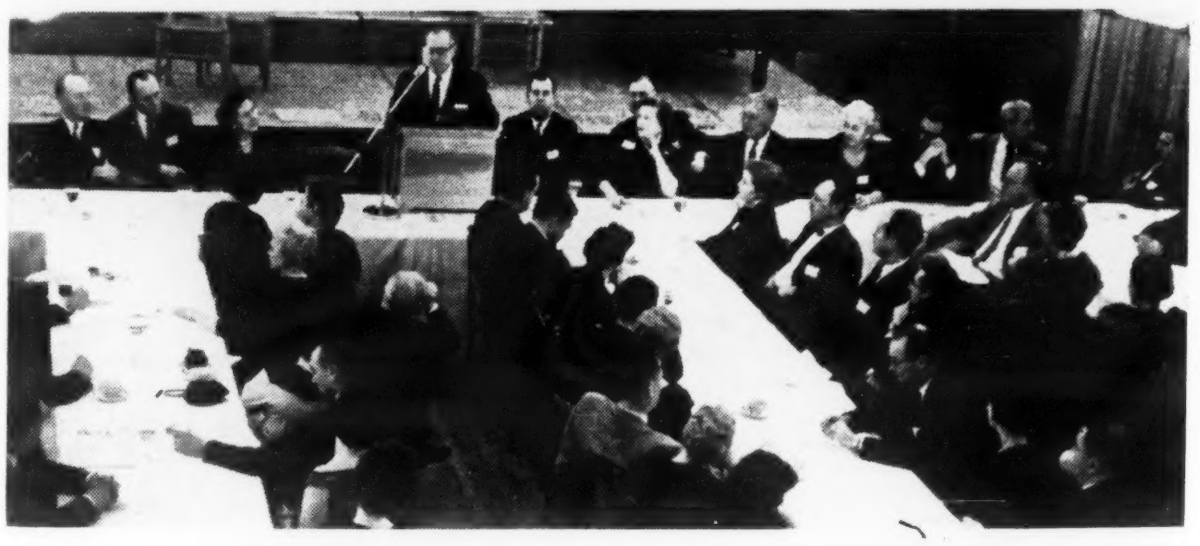
Lexington — *Pictured are newly elected chapter officers. Seated at table L to R: Major K. J. Holmes, Chief, Maintenance Div., Lexington Signal Depot, president; Arthur F. Boyd, Public Relations, General Telephone Co. of Kentucky, executive v.p. Standing, L to R: Major Edgar D. Brooks, Chief Station Liaison, Lexington Signal Depot, v.p.; E. W. Galins, Deputy Chief, Station Liaison, Lexington Signal Depot, secretary, and Merrell Whitmer, Deputy Finance Officer, Lexington Signal Depot, treasurer.*

New York—*Shown at the February meeting are L to R: Don Mitchell, President of General Telephone and Electronics Corp.; Dr. Sheingold, Director, Applied Research Lab., Sylvania Electric Products, Inc.; Robert E. Lewis, President, Sylvania Electric Products, Inc., and Henry Bang, president of the chapter.*

Scott-St. Louis—*Pictured at the February meeting are L to R: Cdr. George W. Laidlaw, USNR, Communications Engineer, American Telephone & Telegraph Co.; Capt. J. K. Hyatt, USNR, Vice President, Engineering, Anheuser-Busch, Inc., who was the guest speaker; Col. George A. Zahn, USAF, chapter president.*

Southern California—*A group photo of the chapter's January dinner meeting.*

Syracuse—*Shown at the head table at the chapter's first meeting are L to R: Glenn Montgomery, Defense Coordinator, American Telephone & Telegraph Co., and Region A vice president; Col. Arthur E. Stanat, Communications and Electronics, 26th Air Division, and chapter first vice president; Mrs. Stanat; James M. Bridges, Director, Office of Electronics, Office of Secretary of Defense, R&E, and the guest speaker; Colin W. Getz, Division Traffic Superintendent, New York Telephone Co., and chapter president; Mrs. Getz; Benjamin H. Oliver, Jr., Vice President, New York Telephone Co., and AFCEA National President; Henry Bang, New York Telephone Co., and New York chapter president; James R. Wescott, General Electric Co.; Mrs. Wescott; Murray Socoloff, Rome Air Force Depot and Rome-Utica chapter president; William Roberts, RCA Service Co.*



Chapter News

(Continued from page 90)

President Edwards also stated that the First Vice President would be chairman of the Membership Committee and the Second Vice President chairman of the Program Committee.

Mr. Thornton Rose, Second Vice President, introduced Brigadier General Joseph W. Stillwell, Jr., Chief of Staff of the 18th Airborne Corp and Fort Bragg, North Carolina, who was the guest speaker for the evening.

President Edwards informed the Chapter that the next meeting would be ladies night to be held April 13, 1960.

Rocky Mountain

The chapter held a dinner meeting at the Fort Carson Officers Club in Colorado Springs on February 11. One hundred fifteen members and guests were present.

Honored guests were Colonel and Mrs. W. C. Garrison, Commander 2nd Missile Command, Fort Carson. Mr. Blair, Vice President and General Manager, Mountain States Telephone and Telegraph Company, Colorado area, presented a very interesting program on the importance of telephone manners.

This meeting marked the termination of General Uhrhane's tenure of office as president of this chapter. He is being transferred to Fort Huachuca, Arizona. General Uhrhane transferred the Chapter Charter and the Gavel to the new president Colonel Howard S. Gee.

Scott-St. Louis

On February 5th the chapter heard an address by Captain J. K. Hyatt, USNR, Vice President, Engineering, Anheuser-Busch, Inc. His talk on "The Cold War" was considered by chapter members to be one of the most impressive in the chapter's history. Following his presentation, Captain Hyatt answered questions from the floor.

Chapter president Colonel George A. Zahn appointed a nominating committee consisting of B. R. Robards (chairman), L. E. Dechant and Lieutenant Colonel F. E. Adams to prepare a slate of candidates for chapter officers and directors for the 1960-61 year.

Robert J. Dennis, Chief Liaison Engineer, Cook Technological Center, Cook Electric Co., presented an illustrated address on "The Dilemma of the Defense Contractor in Advance Planning" at the March 4 meeting.

Southern California

"Technical Overtures to Space" was the topic of discussion at the chapter's March 9 meeting at the Air Force Ballistic Missile Division Officers Club in Los Angeles.

Colonel R. D. Curtin, Deputy Commander, Military Space Systems, Air Force Ballistic Missile Division, was the guest speaker. During World War II Colonel Curtin served with Headquarters, 9th Air Force, in Europe. Since the war, he has been assigned successively as an instructor at the Air Command and Staff School; Director of War Plans, Headquarters USAF; Chief of Staff, 17th U. S. Air Force, and Executive Officer, Weapon Systems, Headquarters ARDC.

NEWS ITEMS AND NEW PRODUCTS

Shown above is Walter Ermer, Sr., of Cleveland, who won the 1959 Edison Radio Amateur Award for outstanding public service in the field of Ham Radio.

Walter Ermer, Sr., of Cleveland is the recipient of the 1959 Edison Radio Amateur Award for public service. The award, sponsored by General Electric Company, was presented at a banquet in honor of Mr. Ermer in Washington, D. C. Principal speaker at the presentation was Major General Earle F. Cook, Deputy Chief Signal Officer of the U.S. Army who discussed the significance of the role of licensed radio amateurs in both peace and war. George F. Metcalf, a vice-president of General Electric, served as master of ceremonies. He described the Edison Award as—"the Nobel Prize of Amateur Radio."

Ermer, who operates amateur radio station W8AEU in Cleveland was selected from more than 30 candidates for his organizing and directing of a 300-man voluntary emergency radio communication corps which served the city on 23 occasions in 1959. This corps provided vital radio communications for emergencies such as flood, storm and tornado warning alerts and searches for lost children. Communications for fund drives and spectator and traffic control at boat and sports car races and parades also were furnished by this group.

• • •

Imports of electronic products into the United States during the first nine months of 1959 totaled in excess of $48.8 million and were more than 2½ times those of the same period in 1958, while exports declined slightly, the Electronics Division, Business and Defense Services Administration, U.S. Department of Commerce, has reported.

Among the increased imports were "radio apparatus and parts." The rapid rise in these imports—from $3.4 million in 1955 to $28.2 million in 1958 to $43.3 million during the first nine months of 1959—is attributable principally to the increased shipments of radio receivers from Japan. Other principal suppliers are West Germany, the United Kingdom and the Netherlands.

The total value of United States exports of electronic products during the first 9 months of 1959 declined nearly 5 percent from the levels of the comparable period of 1958, totaling $261 million. The greatest drop was registered in radio communications equipment—from $91.4 million to $69.9 million—while exports of radio and television broadcast equipment increased by 65 percent. The latter resulted mainly from the rise in exports of television studio equipment, and allied products—from $2.2 million to $7.4 million. There was a decrease of 17 percent in exports of receiving tubes—from $13.4 million to $11.1 million. Exports of television picture tubes increased by 21 percent.

While greater competition by foreign firms both in the U.S. domestic market and in traditional markets abroad is to be expected, judging from trends, there is also evidence of greater participation by U.S. firms in international trade through licensing arrangements with or direct investments in foreign firms.

• • •

Jerome G. Spitzner, 17, of St. James, Minnesota, is the winner of a $7500 Westinghouse Science Scholarship for placing first in the Nineteenth Annual Science Talent Search. His winning project was a homemade ion accelerator.

Jerome won top prize over 39 other high school seniors between the ages of 16 and 18 who had been selected to attend the Science Talent Institute in Washington, D. C., last month. Melvin Hochster, 16, of Brooklyn was awarded $6000 for a project in mathematics; Frank Podosek, 18, of Ludlow, Mass., won $5000 for a study of the effects of heat on liquids; Charles H. Bennett, 16, of Croton-on-Hudson, N. Y., won $4000 for a project on respiration of fresh-water snails, and Betty Lou Sharr, 17, of Oklahoma City was awarded $3000 for a study of the molecular structure of complex sugars. The remaining 35 contestants were awarded $250 each.

Designed to discover and develop scientific ability among high school seniors, the Talent Search is conducted annually for the Westinghouse Science Scholarships and Awards by Science Clubs of America, administered by Science Service, Washington, D. C.

• • •

A series of materials that show simultaneously both ferroelectric and ferrimagnetic* properties has been discovered by the National Bureau of Standards. The generalized composition is a barium niobate containing any one of several rare earths plus iron oxide and has a single-phase crystalline structure. As the two properties seem to be mutually dependent in these materials, the composition should find application in new electronic components where a coupling between dielectric and magnetic effects is desirable or where a magnetic material having a high dielectric constant would be useful.

P. H. Fang and R. S. Roth of the Bureau's mineral products laboratory postulated the existence of a material showing both ferroelectric and magnetic properties at the same time and then examined nearly 90 dielectric compositions before finding one with both types of properties. Once this composition was discovered, additional similar structures were postulated by substituting other atoms at appropriate locations in the crystal.

Samples of the material are made following the usual ceramics laboratory procedures. Some of these compositions were made with the rare earths neodymium, samarium, europium, or gadolinium in one part of the structure and with varying amounts of iron in another part of the structure. All have shown both ferroelec-

*Ferrimagnetism, as distinguished from ferromagnetism, is the property of a material with only partial resultant magnetization because of the presence of anti-parallel magnetic spins.

tric and magnetic properties in a single-phase crystalline form. The presence of both the rare earth and the iron seems to be necessary for the material to show both properties simultaneously; the kind of rare earth has a substantial effect on the Curie points of the composition.

Ferroelectric properties have been confirmed by the presence of the dielectric hysteresis loop and the piezoelectric resonance. The piezoelectric effect was measured on a polarized ceramic disk. Ferrimagnetic properties are verified by the presence of the remanent magnetization and the effect of the replacement of different rare earth ions on the ferrimagnetic Curie temperature.

• • •

A joint United States Air Force-Navy experimental program has uncovered the existence of a previously theorized intercontinental radio channel through the atmosphere, capable of carrying radio waves extraordinary distances.

The project, nicknamed *Tradewinds*, proved conclusively that there is an elevated atmospheric duct which traps and propagates radio waves at very low loss in the South Atlantic tradewinds area between the coasts of South Africa and Brazil. Existence of this duct, created by the temperature inversion layer characteristic of the tradewinds region, was previously predicted in meteorological studies conducted by the Air Research and Development Command's Air Force Cambridge Research Center (Bedford, Mass.), the Naval Research Laboratory and the Electromagnetic Research Corp. (Washington, D. C.). The latter organization originally proposed this project to the Air Force.

Approximately 500 feet thick, the duct is centered at about 5000 feet altitude and extends from West Africa to the Brazilian coast.

Radio equipment operating at a frequency of 220 megacycles was used to measure signal strength change at long distances between two aircraft supplied by the Navy. With only a 100 watt transmitter, signals were detected from Brazil to a point over 1430 miles away. This distance represents the turn-around point of the receiving aircraft and is not the extreme range possible.

"Meteorological data indicates the persistence of the duct all the way to the African coast," said Russell W. Corkum, project engineer at the Air Force Cambridge Research Center's Electronics Research Directorate. "In fact, ducting conditions should be better between Ascension and Africa. There is also some evidence that a ground-based duct out of Ascension Island couples into the airborne duct."

Meteorological characteristics of the duct indicate a stable mechanism is present year round with slight variation in height with the changing seasons. A similar duct is predicted for three other tradewinds areas: North Atlantic, North Pacific and South Pacific.

Future joint programs now being considered include a ground-to-air study of ducting conditions between California and Hawaii, a ground-to-ground program between Ascension Island and Brazil to determine methods of getting radio energy into and out of this elevated duct with ground-based transmitters and receivers, and a meteorological study of the North Atlantic tradewinds region.

• • •

Scientists at Sperry Gyroscope Co., Great Neck, N. Y., have successfully employed a fourth state of matter, known as "gyro-electric plasma," to form a practical electronic circuit. An electric circuit so formed by the plasma has been made to operate as an electronic oscillator to generate radar energy at extremely high frequencies.

The man-made plasma, created by the Sperry scientists, was formed by aiming a slim beam of electrons through rarified hydrogen gas contained in an electro-magnetic envelope. The beam electrons strike the hydrogen atoms with sufficient force to knock them apart and create a plasma of charged pieces of hydrogen atoms and electrons. The "gyro-electric plasma" term stems from the way the charged particles move in a rotary manner analogous to the spin of a gyroscope. Under specific conditions established in the experiment, the plasma behaves as an ordinary electric circuit which interacts with the electron beam and generates microwave radar energy. The plasma circuit couples into the electron beam which then serves as an antenna to convey the radar energy out of the plasma circuit for practical uses.

The research project thus far has generated radar energy at frequencies ranging from 700 to 2000 million cycles per second, which is about 1000 times the frequencies used in radio broadcasting. Sperry scientists indicated that by redesigning their apparatus it will be possible with current technology to generate frequencies more than 100 times higher, a range which approaches infrared waves.

The plasma research project was started by Sperry in 1957 when it was

determined that certain oscillations observed in microwave tubes could not be satisfactorily accounted for. The Sperry Microwave Beam Plasma Research Laboratory was formed to conduct basic research into this branch of physics. Since 1959, the major portion of the work has been sponsored by the Air Force Cambridge Research Center.

• • •

A new broad-band microwave amplifier using all solid-state devices was described by Marion Hines and William Anderson of the Bell Telephone Laboratories at the Solid-State Circuits Conference held in Philadelphia. The amplifier makes use of the negative resistance of the Esaki or tunnel diode in combination with non-reciprocal ferrite attenuation in order to achieve a high amplification ratio without self-oscillation.

The amplifier can be used to increase the strength of radio signals over a broad range of frequencies in the microwave range above 1000 megacycles. Power requirements are low.

The device is built on a traveling wave concept with a row of Esaki diodes along the center of a stripline waveguide. The negative resistance of the diodes causes the power in a signal wave to increase progressively as it travels along the waveguide. By including non-reciprocal ferrite attenuation in the structure, the device is made to absorb waves traveling in the undesired reverse direction and to amplify waves traveling in the desired direction. This allows a large total amplification to be obtained with complete stability by eliminating internal feedback which previously has caused oscillations in amplifiers of this type.

• • •

A mid-continent link in the Army's world-wide communications network was recently dedicated at Fort Leavenworth, Kansas, by Major General Ralph T. Nelson, the Army's Chief Signal Officer, and Major General Lionel C. McGarr, Commanding General of the Army Command and General Staff School, Fort Leavenworth.

The Army's newest and most modern strategic communications station, the Midwest Relay Station is the second of three scheduled to go into service in the Continental United States. The first, at Davis, Calif., began operation in 1956 and the third is being completed at Fort Detrick, Maryland.

The new station, capable of han-

dling 200,000 messages a day, provides the strategic gateway to overseas commands. The $10 million station uses completely automatic message switching instead of the manual tape relay method. This permits receiving, processing and retransmitting messages through the station without human intervention.

"The Midwest Relay Station adds significantly to the Army's global communications capability," General Nelson said at the dedication. "Its dedication is also one of the major events of the Army Signal Corps' Centennial Year and is of special interest to military and civilian communicators throughout the world," he added.

The station is operated by the U.S. Army Communications Agency and serves as an economical focal point through which domestic government installations can conduct routine business.

Principal developers and suppliers of communications and electronics equipment for the station are Kleinschmidt Division of Smith-Corona, Marchant of Deerfield, Ill., and Automatic Electric Co., Northlake, Ill. Automatic Electric provided the automatic switching and routing equipment for the station while Kleinschmidt supplied the teletypewriter equipment.

• • •

In an address at the dedication by Electronic Communications, Inc., of a new manufacturing building, Major General L. I. Davis, Assist. Deputy Chief of Staff, Development, USAF, congratulated the company on their decision to make this investment. He described the rapid growth of ECI as a tribute to the ability of the scientists and engineers that the management has assembled. The new 150,000 sq. ft. building is located in St. Petersburg, Florida.

General Davis commented the investment is a vote of confidence in the future of the defense electronic business. He went on to say that electronics are essential to space operations and, in turn, space offers a real challenge in terms of size, power requirements and reliability; as well as unknown problems so interesting to the scientist and engineer.

The general stated further, "From an engineering viewpoint, I view operations in space as operation in a vacuum — stresses and strains and energy protuberations get vanishingly small. And, in addition, we have data on 99 percent of the excursion from our present operating regime to that of the regime of interest.

"In short, gentlemen, I predict that ten years from now we will say military space operations are practical—in fact, easier than operating in the atmosphere! What were we waiting for in 1960? There was no bogey man in the bell jar."

• • •

W. Wolfson, vice president Marketing, Computer Control Co., Inc., has announced the production of the MIL-T series, a new line of 1 megacycle, digital modules to conform with Military Specifications MIL-E 4159, MIL-E 5400 and MIL-E 16400.

The MIL-T series has been designed to withstand Type 1 vibration, Class A shock of MIL-E 16400, to operate in 95° humidity and condensation and at temperatures between zero and 65° C.

Mr. Wolfson reports that military components of preferred values are used throughout, also, boards and fingers are double etched. Each MIL-T Pac is held within a stainless steel frame, bolted directly to the standard size 19-inch MIL-T Bloc.

• • •

The newly-developed silicon mesa transistor produced by Hoffman Electronics Corporation has a current gain of nearly three times the current industry standard of 2.5 to 20 megacycles, the company reports. Current and frequency characteristics of the transistor are also above industry specifications.

The transistor is the first of a new family of silicon transistors being developed by a research group headed by Norman Golden at the Hoffman Semiconductor Center, El Monte, Calif.

• • •

The Southeastern Signal School, U.S. Army Signal Training Center, Fort Gordon, Georgia conducted an auction of Army surplus equipment via closed circuit television last February.

Television cameras in a warehouse at the Atlanta General Depot transmitted pictures of items to be sold by microwave to a large screen in the ballroom of the Henry Grady Hotel, 13 miles away. An auctioneer in the ballroom with the buyers described each item and regulated the bidding. Camera crew-men at the warehouse listened to the auctioneer over a special audio hookup.

Approximately 110 pieces of equipment, ranging from tire chains to aircraft motors were sold in this way. Besides being a more comfortable


how
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PROTECTS PERFORMANCE and assures
RELIABILITY in Shipboard Installations...
Robinson has pioneered in the development and production of all-metal, low frequency vibration *and* shock mounting systems for the Navy's latest communications, radar, sonar and electronic computing equipment.
These are the **first all-metal environmental control systems** to be accepted by the Navy, and many are already in service aboard the latest missile cruisers, destroyers, aircraft carriers and nuclear submarines throughout the fleet.
This is Robinson Model W664-3 with the Collins AN/URC-32 single sideband shipboard transceiver installed. This all-metal mounting system includes a heavy duty, dual stage base and a stabilizer unit which is mounted on the rear of the equipment.
Exclusive dual stage concept and highly damped MET-L-FLEX® resilient cushions assure the full range of vibration isolation and shock attenuation—double protection for extra reliability! *Send for FREE brochures.*
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DESIGNERS AND MANUFACTURERS OF VIBRATION CONTROL SYSTEMS

method for the buyers, the video version is faster. Conventional auctions usually require a day or more to dispose of as much stock. Depot officials estimated it took about 90 seconds to sell each item via television, five hours for the entire stock.

• • •

Engineers of Barry Controls, Inc., Watertown, Mass., have demonstrated a new approach to shock and vibration problems in the form of vibration resistant structural members designated RIGIDAMP and production assemblies. High damping characteristics are built into the new structural fabrications: the amplification of resonant vibration of the damped structure designs is reportedly substantially less than can be attained by the best current design practice. This reduction is accomplished without use of vibration isolators.

The materials attain their high damping action by special laminated and cellular construction. Sheets and thin rectangular section beams are laminated of conventional materials, either metal or plastic, separated by a viscoelastic damping medium. In flexing under the impressed vibration, the separate laminations of structural material slide relative to each other. This sliding is impeded by the specially formulated viscoelastic material, and most of the energy of resonance is absorbed in straining the viscoelastic layer in shear.

Other structural shapes such as I-beams, channels and angles are of cellular construction rather than laminar. Longitudinal cells are formed throughout the length of the member. Each cell contains an insert separated from the cell walls by the viscoelastic damping material. Patent applications have been made for each type of construction.

The concept of structural damping and the laminated damped structure design was the subject of a colloquium at the 1959 Annual Meeting of the American Society of Mechanical Engineers. However, according to Barry engineers, this is the first practical development of the theory in which all portions of the structural fabrication act as load carrying members, and materials and structures can be designed for optimum damping characteristics in all frequencies normally encountered in modern dynamic environments.

• • •

A 28-channel miniature airborne tape recorder has been developed by the Leach Corp., Special Products Division of Compton, California.

The recorder is cylindrical in form. has a diameter of $6\frac{1}{4}$ inches and length of $6\frac{1}{2}$ inches, and weighs less than 10 pounds. The system, identified as Model I-119, employs the carrier-erase technique using a 30 kc/s pre-recorder carrier. Tape speed is 30 inches per second, providing 30 seconds of recording time. Frequency response is DC to 5000 cycles per second and system accuracy is approximately 5 percent. Company engineers said the device is capable of recording up to 26 channels of information, while two tracks (one for each Leach Model 362 recorder) are used for timing signals from a built-in 10 kc/s oscillator.

The package includes 16 direct-coupled differential amplifiers, each having separate zero balance and gain adjustments. Each channel may be monitored at the recording head. Voltage regulation is provided for the electronic circuitry. Power requirements are 3 amperes DC at 28 volts.

The recording system is being employed by Sandia Corp. on high speed tests connected with development work on non-nuclear components of nuclear warheads.

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Federal employees who occupy key Federal positions and at the same time are members of the Ready Reserve have sometimes found themselves with conflicting instructions as to where they will serve in a national emergency. As key employees of a Federal agency with a mobilization mission, they have vital civilian duties, but as Ready Reservists they are likely to be called to active military duty when their civilian agency needs them most.

The Department of Defense, in an effort to free these essential individuals from conflicting demands, will conduct a screening operation to permit removal from the Ready Reserve of those Federal employees whose civilian positions in government are so vital that they would not be readily available for active military duty in a national emergency. This screening operation, which has been endorsed by the Office of Civilian and Defense Mobilization, provides that each Federal Agency having mobilization functions will identify its key Federal employees who are also Ready Reservists. Key Federal employees are those direct-hire civilians who hold critically important positions, for whom there is no adequate replacement and whose duties cannot be reassigned to others.

The Federal Agency then indicates on an individual Department of De-

fense Status Report (DD-1286) how soon each employee-Ready Reservist can be made available for active duty in a national emergency. The agency notifies the individual concerned and forwards the reports on each to the appropriate military service. These initial reports will arrive no later than July 1, 1960, according to the Department of Defense. After July 1, the Federal Agencies are responsible for maintaining these Reserve Status Reports on a current basis, by forwarding revised reports to the military service concerned whenever the employee's position changes or his availability for military service changes. Final determination of the individual's status will be made by the Secretary of the Military Department concerned.

Individual Reservists not retained in the Ready Reserve because they are not available for active duty in a national emergency will normally be transferred to the Standby Reserve where they can continue to earn credits toward retirement and promotion in the same manner as in the Ready Reserve.

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The Navy has announced the development of a technique for evaluating the condition of aircraft engines. The process consists of analyzing samples of engine oil with a spectrometer to determine the identity and quantity of metals present. A one-ounce sample from the engine oil reservoir is burned between two carbon electrodes in a direct-reading spectrometer which identifies the metals and indicates their quantity. A high concentration of silver in the engine oil indicates a faulty bearing. A large amount of chromium denotes cylinder wall damage and the presence of large amounts of aluminum can indicate piston or valve guide failures.

The new technique was developed by the Bureau of Naval Weapons in its Engineering Materials Laboratory at the Naval Air Station in Pensacola. The Pensacola laboratory successfully adapted a technique which has long been used by railroads and other operators of diesel equipment for identifying and measuring the metal content of engine lubricating oils.

• • •

A cadmium sulfide field-effect transistor has been developed by General Motors Research Laboratories. The development is an outcome of basic research in solid state physics. GM scientists have been growing single crystals of pure cadmium sulfide for

several years and have investigated their properties in detail to get information for electronic circuit devices.

The characteristics of field-effect phototransistors allow them to perform new and combined circuit functions which are not practicable with conventional circuit elements, the company reports. A spokesman for GM pointed out that although cadmium sulfide doesn't compare with germanium for general transistor applications, the GM device has certain advantages as an amplifying photosensitive element. Its amplifying properties can vary greatly and uniquely with intensity and wavelength of light. Output and input resistances of the CdS transistor are higher than normally encountered with junction transistors and vacuum tubes. Conventional amplification at a fixed light level is possible. However, efficient coupling to other active circuit elements is difficult and its advantageous use as an amplifying element is presently limited to low frequency applications requiring high impedance levels such as photomultiplier or ion chamber signal amplification.

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The First U. S. Army MARS SSB Technical Net announces the following program for May:

May 4: "Antenna Panel," by W. Offutt, Engineering Manager; L. DeSize, Group Leader and B. Woodward, Engineer-Airborne Instrument Labs, Inc., Melville, L. I., N. Y.

May 11: "Frequency Control," by Dr. G. Winkler, Scientist, USARDL, Ft. Monmouth, N. J.

May 18: "Communication Electronic Needs of the Future," by Dr. J. Harrington, Div. Head and Dr. B. Lax, MIT Lincoln Laboratory, Lexington, Mass.

May 25: "Fundamentals of Oscillator Operation," by R. Gunderson, Editor, Braille Tech. Press, N. Y.

The net can be heard each Wednesday evening at 9 PM, EST on 4030 kc upper sideband. The net will recess its weekly series following the May schedule and will resume operation in September. (*Turn to p. 105*)

CORRECTION

The name of Dr. William J. Thaler of the Office of Naval Research was spelled incorrectly as Dr. William J. Thayer in the article, "Project Madre," which was published in the March issue of SIGNAL. SIGNAL regrets the error.

A compact mobile radio station with complete integrated voice, telegraph and teleprinter facilities was exhibited at the 1960 Seapower Symposium of the Navy League in Washington, D. C. The equipment, delivered to the U.S. Marine Corps, forearms combat-ready Leathernecks for the dispersed battle tactics of pentomic nuclear warfare.

Mounted on snorkel-equipped jeeps, the systems were engineered by International Telephone and Telegraph Corp. to withstand the rigors of all-weather operation, rough terrain, deep-stream fording and helicopter airlifts. The units were developed at ITT Laboratories and are in production at ITT Federal Division.

Cabinets which house the radio transmitter and receiver can be made watertight to enable the jeeps to be driven through deep streams without damaging the equipment. The jeeps are outfitted with flexible tubing and metal pipe which extend above the canvas roof to enable air intake and exhaust, to and from the engine, even though the main chassis is submerged. If necessary, the 750 pounds of radio equipment and 2,660 pounds of jeep can be picked up by helicopter or cargo planes for quick transfer to strategic areas where they can be employed as a fixed base operation center using 110 volts alternating current instead of the 28-volt jeep power supply.

With a power level of 100 watts, the transmission equipment can communicate to almost any place in the world under favorable conditions and has high reliability under all conditions at a range up to 50 miles.

The units include reels of portable cable which enable operators to range as far as a mile from the jeep with telephone, teleprinters and telegraph keys.

• • •

SIGNAL Magazine considers the following remarks made by Dr. T. Keith Glennan of interest to SIGNAL readers. The remarks were made by the Administrator of the National Aeronautics and Space Administration in a statement before the NASA Authorization Sub-committee of the Senate Committee on Aeronautical and Space Sciences and relate to the transfer of the Army Ballistic Missile Agency's Development Operations Division to the NASA.

"With the transfer to NASA of responsibility for development of the large-thrust launch vehicle systems . . . including Saturn which von Braun's group is working on . . . and with the completion of work on certain military projects, Defense and Army agreed last October on the desirability of the transfer to NASA of this group and the facilities it is using.

"The transfer will be accomplished without interruption of the vital work on Saturn now in progress. As a matter of fact, the detail arrangements are being worked out between Army and NASA in a spirit of complete harmony and cooperation. Since the technical direction of the Saturn program was assigned to NASA, the project has been given the highest national priority, the upper stage configuration has been agreed upon, work is being accelerated with increased overtime wherever needed, and a substantially larger budget for FY 1961 has been requested by the President.

"At the end of the present fiscal year . . . again assuming Congressional approval for this transfer, the NASA will have organized into one government agency what I am confident will stand as an outstanding collection of scientific, technical and supporting personnel. With the continued support of the Administration and the Congress, NASA will carry out . . . purposefuly, vigorously and with a sense of dedication, the space exploration program of the United States.

"With confidence we will meet any competitive challenge in the area of space that this Nation faces today, or that it may face in the future."

• • •

Information systems provide a means of filling the gap between the vast amount of data available on a subject and the relatively small amount which the individual can absorb at one time.

Not new by any means, the idea of automatically gathering information together in a form goes back a few hundred years. However, during the next 25 years these systems will play an ever-increasing role in our economy.

This was the opinion expressed by Dr. G. L. Haller, General Electric Co. vice president and general manager of the company's Defense Electronic Division, at a recent press showing of GE information systems equipment. He further stated, "The information system represents the only valid solution to the mounting information problem by transforming the continuous flow of multitudinous facts and data received by an organization into selected, significant information for decision making on the part of the military commander and the business manager."

Classification and handling of in-

(Continued on page 111)

sig′nal (sĭg′năl), *n.* **1.** a monthly magazine. **2.** provides latest information about communications, electronics, photography. **3.** contains articles by outstanding leaders in military and industry. **4.** editorial policy consistently promotes civilian-military cooperation. — **Syn.** See INFORMATIVE: TIMELY: INTERESTING.

ANALYZE THE TROUBLE WITHOUT INTERRUPTING TRAFFIC

how to reduce down-time on telegraph and data transmission circuits

Radiation's new Telegraph Distortion Monitoring System (TDMS) provides in one compact assembly complete testing, monitoring and signal waveform analyses of telegraph circuits and data transmission lines. This versatile unit makes possible on-line quality control of communications links. It indicates malfunctions, analyzes their causes—without interrupting the flow of traffic.

The Radiation TDMS, with miniaturized components for space-saving compactness, can replace most test equipment now required for teletype maintenance and monitoring. Thus, in addition to reducing circuit outage, the TDMS permits reduction of test equipment costs and increases maintenance efficiency. Portability is achieved at the "push of a button".

For a detailed description of the operation and capabilities of the TDMS, write for Brochure RAD E-100B. Address Radiation Incorporated, Dept. S-4, Melbourne, Fla.

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RADIPLEX—50—channel low-level multiplexer with broad data processing applications. Features rugged solid-state circuitry, almost unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.

RADICORDER—Multistylus recorder provides high-speed instantaneous readout for wide range of data acquisition or processing systems. Eliminates necessity of electronically translating complete data, thereby reduces computer work loads.

TELEMETRY TRANSMITTER—Model 3115 is a ruggedized 215-260 MC unit with extremely linear FM output under the most severe environmental conditions. With its record of outstanding performance in many missile programs, Model 3115 is specified by leading missile manufacturers.

RADIATION
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See our display at NAECON, Dayton, Ohio —Booths 1 and 2; also at AFCEA, Washington, D.C.—Booths 71 and 72.

News Items

(Continued from page 105)

formation within the information systems was explained by Dr. L. E. Saline, Manager of Information Systems for GE. He noted that information can be classified four ways: according to volume which is the quantity of information, content which includes the topics, language or quality. By language is meant how the content of information is expressed. This includes language of speech and language of mathematics which may be expressed in symbols, graphs or electrical voltages as in a computer. Quality consists of the accuracy of the information, that is, it is necessary to know the accuracy of the method used to acquire information.

Information storage, retrieval, manipulation and control are the four ways in which the information is handled once it is within an information system, Dr. Saline said.

• • •

Publication of *Atomic Radiation* (Part II) has been announced by RCA Service Company, a division of Radio Corporation of America.

The 110-page book covers the practical aspects of radiation protection, discussing such subjects as monitoring techniques and instruments, radiation exposure control, decontamination, radioactive material transport and waste disposal.

Intended primarily as a practical guide for industrial, military and research installations engaged in nuclear energy activities, the new book is equally useful as a text for scientific schools and colleges and for civil defense training. The book is available from RCA Service Company, Government Services (210-1), Camden 8, N. J., at $2.65 per copy.

Names in the News

Martin Dubilier has been elected president of International Electric Corp. succeeding **Francis H. Lanahan**, who has been named chairman of the board.

Rear Admiral Stephen H. Evans, USCG relieved **Rear Admiral Frank A. Leamy**, USCG, as Superintendent, U.S. Coast Guard Academy in February.

Maj. Gen. George I. Back, retired Chief Signal Officer of the U.S. Army, and **J. Harry LaBrum**, an AFCEA director, have been elected to the board of directors of Specialty Electronics Development Corp.

Lt. Gen. James M. Gavin, USA (Ret.) has been elected president of Arthur D. Little, Inc. He joined the company as vice president in 1958, following his retirement as chief of Army Research and Development.

John R. O'Brien has been promoted to vice president-government relations in the Military Products Division of Hoffman Electronics Corp. He has been manager of Hoffman's Washington, D. C., office since 1955.

R. Karl Honaman, director of publication at Bell Telephone Laboratories, retired after more than 40 years with the company. Since 1945, he has directed all public relations activities, including press relations, employee information, advertising, technical and personnel magazines, technical libraries and community relations.

John W. Weseloh has been appointed chief engineer of the U.S. Army Signal Equipment Support Agency at Fort Monmouth. With the forming of the Signal Equipment Support Agency, he was appointed deputy chief engineer.

Roy H. Lynn has been appointed president of ITT Communication Systems Inc., Paramus, N. J. The new ITT executive recently retired from the U.S. Air Force with the rank of lieutenant general.

H. S. Williams, vice president and northeastern district manager of the communications products division of Automatic Electric Sales has retired after 35 years as a company representative and executive.

L. H. Orpin has been named manager for planning, defense electronic products, Radio Corporation of America. Before joining RCA, he was director of plans and programs for the Stromberg-Carlson Company.

James O. Weldon has been elected to the board of directors of Ling-Altec Electronics, Inc. and named to the executive committee. Mr. Weldon is president of Continental Electronics Manufacturing Company, a subsidiary of Ling-Altec.

Charles T. Cosser has been appointed director of marketing for Lockheed Electronics, Newport Division. Until recently he was director of marketing for Interstate Electronics Corporation.

David Jacob Heilig, pioneer American radio operator and instructor, died recently. Mr. Heilig co-founded the Philadelphia School of Wireless Telegraphy.

(In this column last month the name of Col. Robert F. Sladek, USAF, (Ret.) was listed incorrectly. We regret the error.)

APPLICATION FOR INDIVIDUAL MEMBERSHIP

SIGNAL MAGAZINE

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